Insects and Disease.—Disposal of City Waste

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Prof. Elie Metchnikoff

The Most Distinguished of Living Bacteriologists and His Work

By Sir Ray Lankester, K.C.B. and F.R.S.

[*THE following article is abstracted from an essay entitled "Metchnikoff and Tolstoy" by Sir Ray Lankester, forming one of a series of popular scientific discourses collected in book form under the title "Science From an Easy Chair" (Methuen and Co.). The author enjoys a personal acquaintance with Prof. Metchnikoff and, is therefore, able to give first hand information on a study of prolonging human life, which has recently attracted wide-spread attention.*—EDITOR.]

The recognition of the derivation of man from animal ancestors, and of the complete community of the structure and the chemical activity of the organs of man with those of the organs of animals, has made the study of the diseases of animals a necessary feature in the understanding of the diseases of man. The far-reaching principle of Darwin that the mechanisms and processes observed in the bodies of plants and of animals (including man) must have been selected in the struggle for existence and perpetuated, because of their utility, led Metchnikoff to inquire what is the value or use of the process called inflammation and of the "eating corpuscles" or "phagocytes" (so called by him) which wander from the blood into inflamed tissues. This question had led him to the discovery that the phagocytes engulf and destroy disease-germs, and are the great protectors of the animal and human body against bacteria and others germs which enter cut and wounded surfaces, and would start disease were there not "inflammation," which is nothing more nor less than a nerve-regulated stagnation of the circulation of the blood at the wounded spot, and the consequent arrival at this spot of thousands of "phagocytes," which pass out of the stagnant blood through the walls of the fine blood-vessels. These armies of phagocytes proceed to eat up and destroy all the germs which fall on to the wound—from the air, from dirty surfaces, and from the skin. The utility of inflammation and its gradual development, according to Darwinian principles, in the animal series, was shown over twenty years ago by Metchnikoff. His important work on "immunity" and on infection and on protection against germ-caused disease is thus seen to be one of the many flourishing and valuable branches of knowledge which have originated from Darwin's great conception and his example in experiment and inquiry.

Metchnikoff is now devoting all his attention to the possibility of prolonging human life. The facts seem to show that if we ate and drank only what is best for us, and led lives regulated by reason and knowledge, we should, nearly all, attain to eighty or even one hundred years of age, having healthy minds and healthy bodies. We should die quietly and comfortably at the end, with much the same feeling of contentment in well-earned repose as that which we now experience in going to sleep at the end of a long and happy day of healthy exercise and activity. Metchnikoff thinks that the cause of too early death may be ascertained, and when ascertained avoided or removed. In 1870, in a little book on "Comparative Longevity," I distinguished what we may call the "possible life" or "potential longevity," of any given human being from his or her "expectation" of life. Potential longevity has been well called our "lease" of life. It is probably not very different in different races of men or individuals, and is probably higher than King David thought, being one hundred to one hundred and twenty years, and not merely seventy years. We all, or nearly all, fail to last out our "lease" owing to accidents, violence, and avoidable, as well as unavoidable, disease; so that seventy years is named as our tenure when the injury done to us by unhealthy modes of life and by actual disease are considered as inevitable. Metchnikoff proposes to discover and to avoid those conditions which "wear down" most of us and produce "senility" and "death" before we have really run out our lease of life.

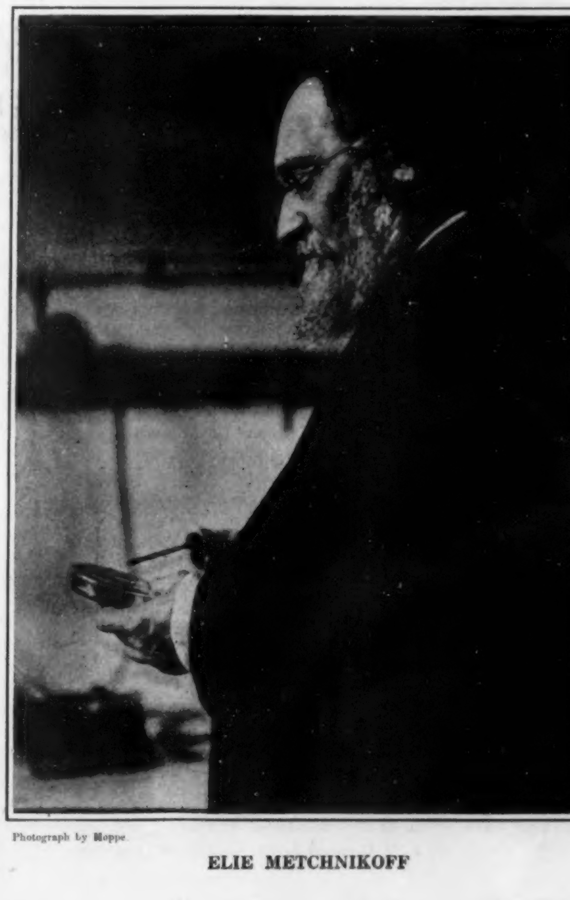
Human beings die most abundantly in the earliest years of life. Statistics show that at birth the chance or expectation of life is only forty-five years, while at ten years old you may expect to live to be sixty-one. At thirty you have not a much better chance—you will probably, if you are what is called a "healthy" life, die when you are sixty-five. But if you survive to be fifty, you may expect, if you have not any obvious disease or signs of "break up," another twenty years, and will probably die at seventy; surviving to sixty, you may expect, if you are what passes for "healthy," to live to seventy-three. Now, it is especially with regard to life after forty or fifty years of age that Metchnikoff is interested. Those who have survived the special dangers and difficulties of youth, and have arrived at this mature age, ought to be able to realize much more frequently than they do something like the full "lease of life." There seems to be no reason why they should not avoid the usual rapid "senile changes" or weakness of old age, and survive, as a few actually do, to something like one hundred. The causes of "senile change" and the way to defeat their operation are what Metchnikoff is studying. Hardening of the walls of the arteries set up by certain avoidable disease contracted in earlier life, and by the use of alcohol (not only to the degree which we call "drunkenness," but to such a degree as to make one depend on it as a "pick-me-up") is an undoubted cause of that weakness and liability to succumb to other diseases which is so general after fifty years of age. The causes which produce hardened arteries can be avoided.

Another cause of senile changes is declared by Metchnikoff to arise from the continual absorption of poisonous substances produced by the decomposition of partially digested food in the lower bowel or large intestine. This is at present the chief subject of his study. It is to prevent the formation of these poisons that he has introduced the use of sour milk, prepared with the lactic ferment.

Metchnikoff has made some very interesting experiments in progress with animals. He used the large tropical fruit-eating bats, or "flying foxes" and also monkeys. Bats have a very short intestine, and very few bacteria and of very few kinds are to be found in its contents. On the other hand, there are as many as thirty distinct kinds of bacteria producing putrefaction or other chemical change in the digestive canal of man—and their quantity is gigantic. They pervade the whole contents of the human digestive canal by millions. By properly feeding the flying foxes in his laboratory in Paris, Metchnikoff actually succeeded in getting rid of all bacteria from their digestive canal, so that he obtained adult mammalian animals, not very remote from man in their structure, food and internal chemistry, which are absoutely free from the intestinal parasitic bacteria which he supposes to cause poisoning and senile changes in man. It is obvious, without pursuing the matter into further detail here, that Metchnikoff is in a position to test his views as to the action of particular kinds of bacteria—he has animals which are free from them. He can make an experiment, keeping some of his bats still free from bacteria and causing some to be largely infected by this or that kind, and he can compare the result in regard to the health and chemical condition of the animals. So, too, the patients from whom the lower intestine has been removed, may very probably furnish him (through his assistant who remains in London) with important facts for comparison with the condition of persons who have not been deprived of this part of the digestive apparatus.

I have given this sketch of what my friend is doing, in order to furnish some notion of the kind of investigation which he pursues. He does not expect to extend the "lease" of human life, but by ascertaining in a definite scientific way the true rules of internal and external "hygiene" he does hope to give mankind an increased "expectation" of life; in fact, to enable a vastly larger number of men and women to enjoy that lease to the full, and to die without disappointment and regret, even with contentment and pleasure, at the end of it.

Metchnikoff was in Russia in the spring of 1909, and spent a day with Tolstoi. They were "feted" and photographed together, the greatest artist and the greatest scientist of Russia. Tolstoi is 81 years of age. He took Metchnikoff out alone for a drive in his pony-cart so as to talk with him without interruption. "What do you think of life?" was the first question he asked, and one which it took my friend some time to answer. In regard to vegetarianism the two great men did not agree. When Metchnikoff declared that there was less cruelty on man's part in killing wild animals to eat them than in leaving them to die by the tooth and claw of predaceous animals or from starvation, Tolstoi observed that that was argument and reason, and that he paid no attention to them; he only guided himself (he said) by sentiment, which he felt sure told him what was good and right!



Photograph by Hoppe

ELIE METCHNIKOFF

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

No Contest for the Gould-Scientific American Prize

FOR the second time Mr. Edwin Gould's generous offer of $15,000 for a safe, multi-motor, flying machine has failed to meet with any effective response. The Contest Committee was present at the field of the Hempstead Plains Aviation Company, which had been, kindly placed at their disposal for July 4th, and as none of the entrants had a machine on the grounds, the Committee had to go through the formality of declaring that there was no contest. Mr. Gould does not feel justified in making a further extension of time, and the prize is now definitely withdrawn.

Of the eleven entrants, only three or four seem to have made any serious effort to build a machine that would comply with the conditions. One of these, a biplane, built by the Burgess-Curtis Company for Howard Gill, was completed, tested in flight and ready to ship; and we greatly regret that the meritorious attempt of this young and promising aviator should have been frustrated by the failure of any other entrant to have his machine ready for the contest.

So far as the other entrants are concerned, the SCIENTIFIC AMERICAN is of the opinion that the failure of the few that made an effort to build machines was due, not to lack of interest in the competition, but rather to the want of adequate means and facilities. But what is to be said of the indifference of the various aeroplane construction companies outside of the Burgess-Curtis, who, having both the aeroplanes and the motors, and experienced pilots, might have placed machines on the field at a moderate cost and with little inconvenience?

We are driven to the conclusion that they are more concerned with gate receipts at flying meets than they are with the development of the art itself for its own sake—a deplorable condition to exist in that very country which gave birth to the first practicable aeroplane.

It cannot be objected that the conditions imposed for this contest were too onerous. Certainly they were not impossible; for while our aeroplane builders are holding back, Germany has shown us the way in most brilliant fashion. The flight of Hirth with a passenger from Vienna to Berlin in a two-motor, two-propeller monoplane, at a reputed average speed of sixty miles an hour, was a feat far more difficult, surely, than that demanded under the conditions of the Gould-SCIENTIFIC AMERICAN Prize.

Nor can it be urged that the object which prompted Mr. Gould's offer was wanting in appeal. If we were asked to name the quality in an aeroplane which, just now, is most urgent in its demand for consideration, we should unhesitatingly name that of safety. The alarming number of aviators of experience who have fallen to sudden death during the past few weeks should be taken as a loud call for any device of a practicable nature that will render aviation reasonably safe—and among these, the provision of separate motors and propellers, with one plant normally in reserve, must always hold a high place. The prize which is now withdrawn was notable as the first and only offer made for an improvement whose object was to protect the life of the aviator, and render the new art reasonably safe.

Mr. Gould's generosity, to say nothing of the several inducements offered by certain leading papers, has silenced the complaint of the aviators that they do not receive, in this country, the financial assistance which has carried aviation in Europe to its present commanding position.

The Death of Melvin Vaniman

WE have spoken somewhat glibly of the "Conquest of the Air," until the phrase has become trite, and savors of platitude. Yet almost daily we are reminded only too forcibly that the air is not yet conquered, that the battle with the element is still being waged, and is claiming its full toll of human life. We follow with interest and pride the records that are newly established almost every week in the field of aeronautics. A mournful record belongs to last week. On Tuesday, July 2nd, Melvin Vaniman, with his crew of four men, met their death as the result of an explosion aboard the "Akron," the airship on which Vaniman hoped to cross the Atlantic; on the previous day Miss Quimby and Mr. Willard were dashed to death from a monoplane.

When we read the roll of victims that the air has claimed, or the account of the heroic manner in which the men aboard the "Titanic" met their death, for a moment some of us may feel our scientific creed shaken. What of the principle of the survival of the fittest? Is it not the brave and daring, the heroes, that are being swept away, while their less enterprising or more timid fellows are preserved in the safety of common everyday life? Are the brave, therefore, to be classed among the "unfit," to be weeded out in the progress of time? The answer is not far to seek. Some individuals must be sacrificed that the community may benefit. Just how this benefit arises we may not always be able to see in any one specific instance. But can we doubt that the nation which harbors such characters as Vaniman, or whose men stand up under the test of death as did the passengers of the "Titanic," will carry off the victory in the battle of nations, whether in actual warfare or in the industrial contest of peace? Such a nation is "fit," because it numbers in its population men who risk their life in the cause of the advancement of arts and knowledge, or who sacrifice it unflinchingly for the sake of high principles.

Vaniman, like many an inventor before him, died a victim to his own theories; and his sudden taking off is rendered the more pitiful by the fact that his theory was correct, and had he only waited for the completion of his new "wire-cloth" machine, he might have escaped disaster.

In seeking to construct a dirigible of constant displacement, with a shell of sufficient strength to withstand the increase of pressure due to rise of temperature, he was treading the one road—at least so we judge—along which development of the dirigible must proceed, if it is to become a really practical machine.

Let no one make the mistake of placing this man among the mere dreamers. He was practical, clear-sighted, and logical. His conception of a constant-displacement machine was based upon sound theory and practical experience, gained in his earlier work. His comparison, in conversation with the writer, of the spherical drifting balloon, with its steady loss of gas, to a ship that is launched with the certainty that it is leaking so badly that it will soon go to the bottom, was quite to the point. "A ship is water-tight and rigid, and my airship must be reasonably rigid and gastight," he said.

Vaniman has left behind him in his wire-cloth fabric a material which may yet prove to be the solution of a hitherto unsolved problem. The failure of his weaker rubber-cloth fabric to stand the tangential stress proves only that in this particular case it was unequal to its duty. The wire-cloth is over 30 times stronger, and it is to be hoped that the line of investigation which has been opened by Vaniman will be followed up by the interests which were behind his meritorious if tragic attempt.

Doctors of Civilization

READ the terse yet masterful account that Thucydides gives of the "Black Death," a scourge which, despite their remarkable civilization, the ancient peoples clustered in Southeastern Europe and Asia Minor were unable to combat, or peruse Pepys' description of the terrible ravages of the Great Plague in London, and the thought strikes home that the gregarious instinct of man cannot be satisfied without paying a tragic toll. The diseases of perilous occupations, the accidents due to unprotected machinery, the ills obviously caused by poor ventilation, all these can be avoided by the ingenuity of the architect and the engineer. But the pests that have decimated even a rural population are not prevented in any obvious way. Their origin is hidden in wells that apparently yield only pure water, in the bites of insects apparently harmless. They are, in truth, diseases of civilization, which require for their eradication scientific investigation as painstaking and self-sacrificing as the researches that have given us the wonderful antitoxins and sera by which we cure typhoid fever, diphtheria, pneumonia and other maladies, formerly considered fatal.

Not until the bacteriologist with his microscope and his stains had discovered the germs, invisible to the naked eye, that are responsible for most of the ills which flesh is heir to, did it become possible to create the modern profession of sanitary engineering—to educate, in a word, the doctor of civilization. Prevention is the watchword of that new profession—prevention of the conditions under which deadly bacteria may thrive and prevention of the transmission of these bacteria should they breed. Not without the sacrifice of men who could ill be spared has this truth been learned. Heroes have been found, willing to subject themselves to the stings of bacteria-carrying insects, in order to prove that not the exhalations of swamps but the natural inoculating needle of the mosquito is the real cause of some infectious diseases; that miasmas do not in themselves cause ills, but simply aid the breeding of the living vehicles that carry disease germs.

Within the lifetime of living men it was thought that only a physician was fitted to be head of a Board of Health. Even in the smaller towns a medical man is still found intrusted with the well-being of hundreds and perhaps thousands of town dwellers. Gradually, the new doctor of civilization, the sanitary engineer, the public health expert trained to cope not with the ills of individual human beings but with epidemics that devastate whole communities, is coming to the front. Such is the need for these men that our technical institutions are now offering courses in sanitary engineering. To the Massachusetts Institute of Technology belongs the credit of having, years ago, established the first of these under the guidance of Prof. W. T. Sedgwick. Other institutions soon followed. They have all justified their existence by graduating many students, now actively and successfully engaged in public health work. Not many years will pass when the health of every community will be intrusted not to a graduate physician but to a trained public health expert.

Lunacy and Morals

CHIEF SURGEON PICQUE, of the Seine Lunatic Asylum, is reported to have addressed the Academy of Medicine in Paris on the operative treatment of forms of insanity arising out of appreciable lesions, such as abscesses and tumors of the brain and nervous system; or out of such affections of other organs, remediable by operation, as may affect cerebration through extension of their toxic products in the lymph and blood channels. Unquestionably such surgery may prove effective; the like work of other surgeons has proved so. In some idiots, moreover, mental regeneration seemingly miraculous has come after thyroid transplantation, or after the medical administration of the thyroid extract of the sheep.

Here there is no occasion for skepticism. One does not, however, altogether follow those who claim surgery to be efficient in the cure of human immorality. A brain tumor is a tangible, material thing; but an immorality (or is it an un-morality?) is an entity so metaphysical, so conditioned upon the will, that it were difficult to see how surgery can be effective in the premises. And yet it is worthy of reflection that in any prison one sees microcephalics, scaphocephalics and other unfortunates so born with anatomical stigmata that their moral sense is blunted or perverted. Such are unable to feel responsible for whatever unlawful acts they have committed; the insane asylum, not the prison, should be their place of confinement.

The difficulty is that one cannot always see clearly the line separating responsible wickedness from acts against the public peace which have their origin in perversities of the psychic apparatus. The difficulty would be largely cleared up if definitions of mind and morality acceptable to everybody could be formulated. To the scientist morality is the crystallization of natural law, a definition that might help to some very fair conclusions.

Many humanitarians now hold extreme views as to irresponsibility for criminal acts—views which, if generally accepted, would surely imperil the social structure. It has indeed become very difficult, to such extreme has the pendulum now swung, to convict those who have committed the most heinous crimes. Besides, there is a tendency to make prisons so comfortable that one is puzzled why those against whom indictments have finally been secured, do not immediately enter these luxurious institutions, instead of wasting so much of the time of jurymen, and so much of the public funds, in proceedings which so rarely end in conviction. There is, moreover, constant agitation for the substitution of trepanning for hanging, of optometry for trial by jury; such depravity as may not be eradicated by the dentist, or by the nose and throat specialist, or by the adjustment of proper spectacles, may nevertheless, by the exercise of a little considerate patience, yield to deep breathing, or the rest cure, or the hot air apparatus, and the like.

Engineering

Gas Engines in High Altitudes.—A gas engine, says *Science Conspectus*, was erected several thousand feet above sea level. The engine did not give the power expected, and it was concluded that the loss was due to the altitude of the station. Upon investigation of the theoretical and practical considerations involved, it was found that there is a loss of about 1 per cent of the indicated horse-power for each 1,000 feet of increase in elevation. The effect with a low ratio of compression is slightly less than with a high degree of compression.

The Power of an Air Brake.—Some idea of the power of an air brake may be gained from the following facts: It takes a powerful locomotive drawing a train of ten passenger cars a distance of about five miles to reach a speed of sixty miles per hour on a straight and level track. The brakes will stop the same train from a speed of sixty miles per hour in 700 feet. Roughly, it may be stated, says *Science Conspectus*, that a train may be stopped by the brakes in about 3 per cent of the distance that must be covered to give it its speed.

Anti-"Baggage-Smasher" Mats.—We have received from the Pennsylvania Railroad Company drawings of an interesting and, we are told, very successful cushion for unloading baggage from trucks in baggage rooms. The mats, which are 22¼ inches wide by 4 feet 4 inches long, are made of four strips of hard wood, 4 inches wide by 4 feet 4 inches long, across which are nailed 24 pieces of scrap air-brake hose. We are informed that the mat does its work admirably, of which fact no doubt the prospective railroad traveler will take due notice and comfort.

Utilizing Panama Canal Plant.—We have received from Mr. Frank Vanmeter, of Canton, Ill., a suggestion that a part of the dredging and excavating plant at the Panama canal might be shipped, when the canal is completed, to the Mississippi Valley, and there used by the Government in re-building and enlarging the present levee system. It is suggested that the excess material dredged from the river might be utilized in filling up a part of the adjacent low-lying lands, and that this would at once serve the double purpose of increasing the flood capacity of the river and recovering land which is now subject to flooding.

Electrifying a Canadian Steam Railroad.—An important work of electrification is being done on a section of the Rossland Division of the Canadian Pacific Railway, in British Columbia, extending from Rossland to Castlegar Junction. The Rossland Division is 29.3 miles in length, and if the sidings and tracks in the yard are included, the total length of track to be electrified is 43 miles. Current at 60,000 volts will be received from the West Kootenay Power and Light Company, and the hauling will be done by four 75-ton electric locomotives. It is yet to be determined whether alternating current at 6,600 volts, or direct current at 2,400 volts, will be employed.

The World's Largest Building.—The first day of July the topmost piece of steel work was riveted in place on the Woolworth Building in New York. This structure is notable as being the loftiest building devoted to business purposes in the world. From the sidewalk to the top of the cupola is 750 feet, which is 50 feet more than the height of the Metropolitan Building in this city, and 138 feet more than the height of the Singer Building tower, also in New York. The building contains fifty-five stories in the tower. It is of the standard steel column and floor beam construction; but in order to take care of the enormous dead load and the great wind load, the columns are necessarily of unprecedented size.

The Inner Structure of Metal.—J. Alfred Ewing, in delivering the May lecture of the Institute of Metals, drew attention to the fact that when it was desired to examine a metal microscopically, the first step taken was to polish the section. As Dr. Beilby had shown in the previous May lecture, this polishing seriously affected the constitution of the surface, making it quite different from that of the metal below. It produced an amorphous layer, distinct in constitution from the crystalline structure, which became apparent when this layer was removed. This removal was commonly effected by a light chemical attack, the metal being etched by a weak acid. It could also be done by heating the specimen and subliming away or evaporating off the amorphous phase.

Cape Cod Canal Progress.—When the delegates of the recent International Navigation Congress visited Cape Cod, they were assured that this work would be opened to traffic during the winter of 1913, or at the latest in the spring of 1914. The canal will provide a 25-foot depth from Barnstable Bay to the 30-foot depth in Buzzards Bay, a distance of 12½ miles. The minimum width on the bottom will be 200 feet. The canal will enable ships to avoid the dangers of the stormy outside passage around Cape Cod, and it will shorten the distance from Boston for ships passing through Long Island Sound by 66 miles. Fifty thousand vessels of a total tonnage of 25,000,000 and carrying 500,000 passengers pass around Cape Cod every year, and the majority of this traffic, it is expected, will seek the shorter and more sheltered route.

Electricity

Condensers on Lighting Circuits.—The use of condensers to obtain better economy and power factor on the circuits of low-voltage lamps has been rendered possible by improvements in the manufacture of tinfoil and paraffined paper condensers. By immersing the condenser roll in melted paraffine after vacuum impregnation, and subjecting the paraffine to high mechanical pressure during cooling, thorough durability, and efficiencies up to 99 per cent at full load, are readily obtained.

Street Cleaning by Electricity.—In several German cities street washing machines driven and operated by storage batteries are in operation. The machine employed is a 3½-ton vehicle equipped with a 40-cell battery giving 200 ampere-hours at the 5-hour discharge rate, with traveling speeds of 4, 6 and 9 miles per hour. It carries a heavy tank of water, brushes, and rotating rubber scrapers. There are 24 of these machines at work in Berlin at present, with six special charging stations, and each machine covers 18 to 25 miles per day and costs less to operate than a horse-drawn machine.

A New Light-weight Storage Battery.—The present capacity of lead-plate storage batteries capable of withstanding the shocks of ordinary mechanical usage to which they are subjected in automobiles, electric cars, and railroad trains is stated to be 30 to 35 watt-hours per kilogramme of battery. The principal of the Royal Technical College, Copenhagen, has announced the invention of a lead-alloy storage battery the plates of which are extremely porous so as to increase the active surface in contact with the electrolyte. At a discharge current density of about 0.005 amperes per square centimeter, which is the normal for ordinary train-lighting cells, and an ampere-hour efficiency of 91 per cent, the capacity of the plate of the new battery is stated to be 4½ times that of the ordinary battery plate.

Crystallization of Metal Lamp Filaments.—It is well known that the metal filaments of modern incandescent lamps become more fragile after use. A recent investigation of the changes set up in metallic filaments by use, including a microphotographic study of both "drawn-wire" and "extruded" filaments, has proved that the continued high temperature at which the filaments are run causes the metal to crystallize. The coarse crystals which ultimately mean breakage of the filament are built up by accretion upon the fine crystals in the original structure of the metal. Drawn-wire filaments, having a finer initial crystallization, are stronger at first, but show no advantage over the extruded filaments after both have become crystallized.

Electric Lighting for the British House of Commons.—The electric lighting which it is proposed to substitute for gas in the debating chamber of the House of Commons is to consist of groups of three metal filament lamps inclosed in a holophane globe and placed over a square pane of amber tinted glass. This provides three thicknesses of glass, which are depended upon to cut off ultra-violet rays. Uniformity of illumination is to be secured by the dispersing effect of the globes. The amount of illumination on the benches, now obtained by gas lighting, is four-fifths of a candle-foot, and the same amount or more can be obtained by the electric light—one candle-foot being usually considered requisite for reading purposes.

Detecting the Proximity of Icebergs.—A Canadian physicist has devised a microthermometer for detecting the proximity of ice at sea by observing the temperature effects in the water currents around the mass of melting ice. The instrument for this purpose is inclosed in an iron cylinder, arranged to be submerged about five feet below the surface of the water and is connected by cable to an electrical registering and recording device on deck. This sensitive apparatus registers temperature variations otherwise entirely overlooked, and indicates the presence of an iceberg at a distance of half a mile. The character of the temperature changes and the rate at which the changes take place are found to be more significant for determining the presence of ice than the temperatures themselves.

Advantages of Electric Locomotives.—A recent paper on electric locomotives for the handling of freight in railroad yards and in mining brought out clearly certain advantages over steam locomotives apart from the elimination of fire and smoke and the difference in fuel efficiency of the central station boiler and engine and the (smaller) locomotive boiler and engine. The electric locomotive can be relied upon, as long as the line voltage is maintained, to develop its full power at any time, being independent of the state of a boiler, the skill of a fireman, or the quality of fuel. The track adhesion is better—sometimes as much as 20 per cent better—because the torque of the driving wheels is uniform throughout each revolution, and there is not the same tendency to slip when starting under load as in the steam locomotive. The traction can be increased indefinitely by sanding the rails, since the electric locomotive can draw power indefinitely from the line. No time is lost on the road for coaling, watering, boiler tending, or waiting for steam pressure to rise.

Science

Dr. de Quervain's Trans-Greenland Expedition is now under way, the party having sailed from Copenhagen for the west coast of Greenland the end of April.

Tenth International Geographic Congress.—This much-postponed meeting is, according to the latest announcement, to be held in Rome in the week beginning March 27th, 1913.

A Dry Month in England.—During April, 1912, the total rainfall registered at Greenwich observatory was only 0.02 inch. This is the driest month recorded at that observatory, at any period of the year, for 100 years.

Dr. S. Rona, late vice-director of the Meteorological and Magnetic Institute of Hungary (the national weather service of the country), has been appointed director of that institution.

Explorations in Iceland.—A remarkable series of explorations was carried out in Iceland during the years 1910 and 1911 by a Swiss traveler, Herm. Stoll, who covered a distance of over 5,000 kilometers (upward of 3,100 miles) in the course of the two years.

Finger Prints in Banks.—German banks, according to newspaper dispatches, have begun to introduce the finger print as a mark of identification on checks. The method is already in use in the United States.

Climatic Statistics of the British Isles.—A joint committee comprising two representatives of the Meteorological Office and two of the Royal Meteorological Society is planning the publication by these two organizations of a collection of climatic normals for the British Isles. Barometric pressure and wind direction will be first dealt with.

Designs for the Australian Capital.—According to press despatches the first prize in the competition for designs for the new seat of government of Australia, viz., £1,750 ($8,516), has been awarded to Walter Burley Griffin of Chicago; the second to Eliel Saarinen of Helsingfors, Finland; and the third to Alfred Agache of Paris. As decided three years ago, after long discussion, the new capital city is to be built in the Yass-Canberra district of New South Wales.

Another Attempt to Scale Mt. McKinley.—The Bulletin of the American Geographical Society reports that the expedition to Mt. McKinley which left Fairbanks, Alaska, on February 5th, fitted out by a newspaper of that town to attempt the ascent of the mountain, returned unsuccessful on April 10th. An elevation of 10,000 feet was reached on the north side of the mountain east of Peter Glacier, where precipitous ice cliffs prevented further progress.

The Harbor of Colombo.—In 1875 the late King Edward VII, then Prince of Wales, laid the first block of the southwest breakwater of the harbor of Colombo, Ceylon. Prior to that time the harbor had been an open roadstead, exposed to the full violence of the monsoons. On May 1st of the present year the Governor of Ceylon, Sir Henry McCallum, laid the final stone in an extension of the southwest breakwater, thus completing the construction of one of the finest artificial harbors in the world, which is a square mile in area and capable of accommodating 40 to 50 vessels of over 12,000 tons. The total cost of construction has amounted to about $15,000,000.

Banana Flour.—Banana flour specially prepared as a tonic food is making its appearance in Paris under the name of Bananéine. It is to be remarked that within a recent period this fruit was but little used in France, and even now its consumption is limited. However, measures are being taken to increase the importation, and it is said that 70 vessels were recently fitted up for bringing the fruit to Europe. Banana flour has a much more extended use in England than on the continent, but efforts are now made to introduce it in France owing to its great nutritious value. The bananéine is a preparation made for convenient use, and it contains 60 per cent of banana flour, this being put through a sterilizing process at the proper heat.

A Rubber Substitute from Sea Fish.—A press statement forwarded by Consul Frank W. Mahin of Amsterdam, tells of a factory established at Ymuiden at the mouth of the North Sea Canal in Holland to produce a substitute for rubber, and it is reported that the company operating the factory has succeeded in producing a substance having the qualities of rubber and some special advantages over the genuine. While the process is a secret the principal ingredient is said to be fresh sea fish, which are brought to Ymuiden in vast quantities by the Dutch fishing fleets. According to report 15 to 16 per cent of natural rubber is added to the fish, and the result is a substance as flexible and elastic as rubber, but much cheaper—about as 1.25 to 8 in price, compared with real rubber. The low price of this product will be caused partly by the by-products which are possible, for it is said that much albumen will be made from the fish and that half of the factory is arranged for the manufacture of fertilizer.

The Disposal of a City's Waste

How Refuse Equal in Weight to Ninety "Titanics" is Handled by New York and Other Cities

By Franz Schneider, Jr., Research Associate in the Sanitary Laboratory of the Massachusetts Institute of Technology

Gulls in the wake of garbage scows.

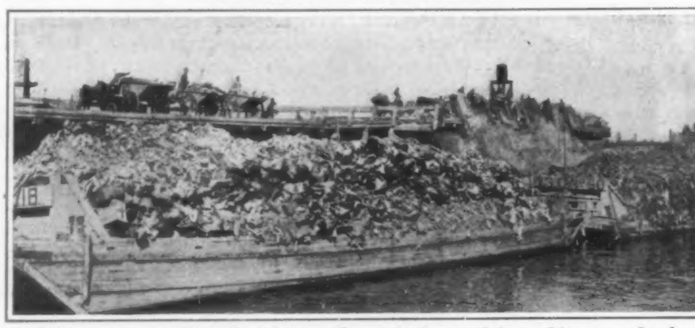
At the head of this article is a picture of the garbage disposal by dumping at sea, not a sanitary way, but at the same time in use by some of the large American cities. The number of gulls may serve as a measure of the enormous quantity of refuse, portions of which are almost certain to be stranded on neighboring beaches.

If the entire year's refuse of New York city could be gathered together, the resulting mass would equal in volume a cube about one eighth of a mile on an edge. This surprising volume is over three times that of the great pyramid of Ghizeh, and would accommodate one hundred and forty Washington monuments with ease. Looked at from another standpoint, the weight of this refuse would equal that of ninety such ships as the "Titanic." When it is remembered that this volume does not include sewage or other liquids, but only the dry, or relatively dry, parts of the city's wastes, it is evident that the problem of refuse disposal is one of the first magnitude, calling for great engineering skill and the expenditure of large sums of money.

The material is burdensome not only on account of its great bulk, but because of its extremely heterogeneous nature. In agricultural districts the matter is relatively simple: garbage is fed to the stock, old paper and other combustible material are quickly burned, and the unburnable rubbish goes to an unobjectionable dump heap. In the city, however, matters are much more complex. Ashes here become an important factor in the disposal problem, forming one half of the entire refuse by volume and two thirds by weight. Street sweepings, containing much horse manure and ordinary dirt in various guises, must also be cared for. The diversified nature of the city's industries and occupations is, of course, what operates to make the refuse so extremely heterogeneous. Almost any conceivable object, ranging from orange peel to bicycles, and from mattresses to dead animals, may appear. In attacking the problem, however, four general classes of refuse are recognized: garbage, ashes, rubbish, and street sweepings. Special wastes—as from slaughter houses—will be encountered, but the main phases of the problem are indicated under the above headings. Disposal may be said to have a two-fold object: to dispose of the material without nuisance or injury to health, and to attain this end at the minimum expense.

Methods of Collecting Garbage.

Any comprehensive plan for complete disposal must take cognizance of the methods of collection. If separate treatment is to be given to garbage and rubbish, it will be advantageous to have the householder put the two in separate receptacles, and separate systems of carting will also be indicated. If, on the other hand, the garbage and refuse are to be treated together, as they are in England, there will be no advantage in separation by the householder or in any separate systems of collection. The means of collection and disposal at present in vogue are almost as varied as the character of the material itself. There are different methods for each of our classes of refuse, and from these a very large number of plans for complete disposal may be devised. The determination of the best combination of methods for a given community is a matter of very considerable difficulty, and calls for special knowledge and engineering skill. It is sufficient here merely to note the inter-relations of disposal and collection schemes, and to pass on to a consideration of the principal methods in vogue in treating each of our four sub-divisions of refuse.



Filling scows with refuse (not garbage) to be used in making new land.

Garbage, ashes, sweepings, when collected in the Borough of Richmond (New York) are thrown into a refuse destructor, where it is burnt into clinker. This clinker can be utilized in the same manner as broken stone in concrete construction.

The tanks contain grease obtained from New York garbage.

Let us consider first the disposal of garbage. In small communities the garbage is often sold or given to the farmers, an arrangement satisfactory in many cases from the standpoints of sanitation and cost. Again, it may be plowed into the ground, although this is now rarely practised. In larger communities collection and disposal to farmers is increasingly difficult, and this method becomes impracticable. Recourse is sometimes had in this case to mere dumping, either on land or water. The practice of dumping garbage on land is one that cannot be defended from aesthetic or sanitary standpoints. The dumps become ill-smelling eyesores, and are ideal places for breeding of flies. Dumping in water may be attended by serious nuisance arising from material drifting back onto the shores, and, like land dumping, is at best a profitless enterprise. When the community is of sufficient size, say someting like a hundred thousand population, these primitive methods may be discarded and more scientific ones—attaining more perfect disposal, and sometimes capable of actual profit—may be adopted. These are methods of reduction and incineration.

Reduction and Incineration.

In the so-called reduction treatment of garbage, the aim is to recover the grease from the material. Ordinary garbage contains, as a rule, 2 per cent, and sometimes as much as 3 per cent, by weight of grease. Reduction and the coincident recovery of grease are accomplished in two general ways. In the first, the garbage is cooked in large closed retorts by means of steam under pressure. After about a half hour's

digestion, the material is put through presses, removing the water and grease and leaving behind a comparatively dry cake, known as tankage, which has some value as fertilizer stock. The grease is skimmed from the water, purified roughly, and barreled for the market. In the other method of reduction the grease is extracted by some volatile solvent like naphtha. The garbage is sometimes dried as a preliminary to extraction. At all events, it is heated in contact with the solvent in closed vessels, after which the solvent is distilled off and the grease recovered. In both of these reduction processes the end products are the same, i. e., grease and fertilizer stock. Whether under ordinary conditions of operation the value of these products is sufficient to cover expenses is a debated question. In some instances, as at Columbus, O., the sale of the products has seemed to meet expenses. In a majority of cases, however, the process is carried on by private companies which must be subsidized by the city. This method of disposal is attractive from an economic standpoint, recovering, as it does, something valuable from an apparently valueless material. It is only fair to say, however, that reduction is usually attended by objectionable odors, making imperative the location of these plants at some distance from the city, and so adding to the expense of haulage. This may be regarded as distinctly American, being little practised abroad, where another method, that of incineration, is the favored one.

Garbage disposal by incineration must be considered with regard to our other classes of refuse. In this method the heat for incineration must be obtained not only from the garbage itself, but from ashes and other combustible waste. It is here that the distinction between incineration and the little-used cremation enters. In the former, the heat is obtained from the refuse itself; in the latter the garbage is burned at the expense of some regular fuel, such as coal or oil. Incineration is carried on in specially constructed furnaces. Garbage is mixed with the other refuse in the proper proportions and special devices are employed to feed the material into the furnaces so as to secure the best results. This method of disposal is entirely satisfactory from the sanitary standpoint, and gives, under proper operation, a slag or "clinker" which is valuable in construction work, while the resultant heat may be transformed into steam or electrical power. In the earlier attempts at incineration, using natural draft, the furnace temperatures were too low; objectionable smoke, noxious odors, and an undesirably soft clinker resulted. With the introduction of forced draft, these difficulties have disappeared, and in Europe, and in England especially, the disposal of the city's refuse by this method is complete, unobjectionable, sanitary, and sometimes profitable. Boilers are installed in the incinerators which will furnish relatively large amounts of valuable power. This may in turn be utilized for the generation of electricity, or for pumping when the incinerator is located in conjunction with water or sewage disposal works. On account of the unobjectionable nature of a properly designed and operated incinerator, it may be located in the center of the city, thus reducing the expense of haulage. As has already been indicated, there is a vast difference of opinion as to the comparative merits of reduction and incineration. Reduction has been a favored method in this country, but, owing to the large extent to which this process is in the hands of private interests, the facts as to the actual costs of the enterprises have not been fully available. In England, incineration has reached its highest development, and there appears to be an increasing use of this method in our own country.

The Objectionable Method of Dumping.

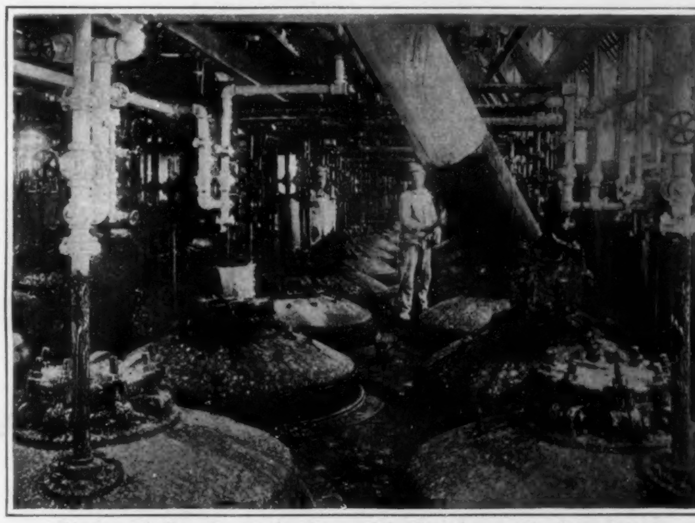
The favorite way of disposing of ashes is by dumping, either on land or in the water. Ashes are often of real value as filling-in material for made land. Theoretically the land dump is merely unsightly and dusty; there is not the sanitary objection that may be urged against the garbage dump. But practically, from the fact that it is impossible to secure the proper separation of wastes by the tenant, the ash dumps in a crowded locality are largely garbage dumps with all their disadvantages. One must not forget, furthermore, that the ordinary run of ashes contains a very considerable amount of useful heating value which is lost when dumped.

The dumping of ashes and rubbish into water is open to much the same objections as the similar dumping of garbage. Unless the material is carried far enough from shore, and conditions of wind and tide are favorable, serious nuisance is certain to arise. The cost of carrying the material an adequate distance from shore then may become very considerable.

Rubbish, making up about a quarter of the total by volume and a sixth by weight, may be sorted over, paper and other combustible material removed and sold or burned for heat, while there is some salvage in junk. This picking over of rubbish is very dusty work, and there is a question as to its effect upon the health of the workmen.

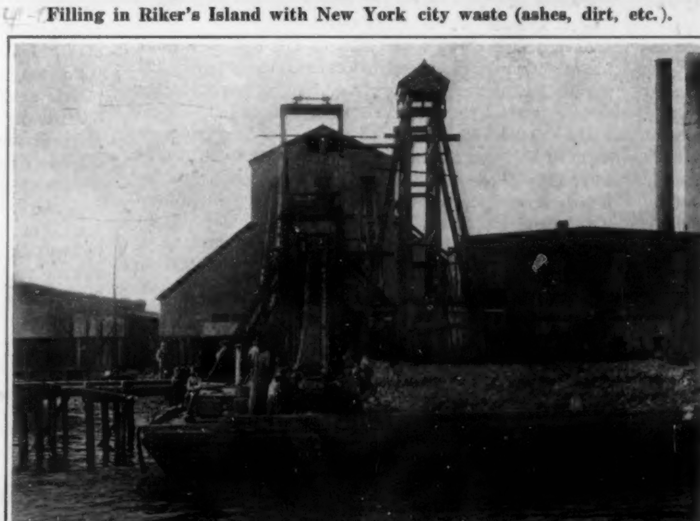
Street sweepings with their manure may be plowed into the ground, or may be dumped, or may be disposed of in the incinerator. The last of these alternatives is perhaps the most desirable.

These are, briefly, the various methods by which municipal refuse is now being disposed of. The more primitive methods, as the selling of garbage to farmers, and dumping indiscriminately, are showing a tendency to disappear. They are being replaced, more especially in the larger cities, by the more scientific methods of reduction and incineration. The actual detailed plan which will be the most efficient for a given community can be determined only after an investigation of the nature of its refuse, and by the character of the community itself and its surroundings. The objects which must be carried in mind in making a selection of methods are to remove the wastes quickly and completely from sight without the creation of nuisance or danger to health, the recovering of whatever is valuable, and the carrying on of the whole operation at the minimum expense. The field of refuse disposal is one in which there is great variety of opinion and, perhaps, a lack of scientific practice. It is one, however, which by its magnitude and financial importance is worthy of the attention of our best engineering talent.

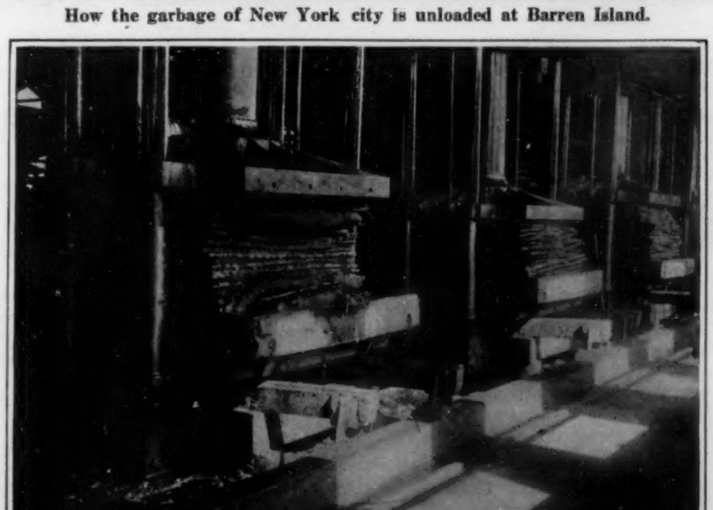


Chute and digesters at the Barren Island garbage reduction plant.

Filling in Riker's Island with New York city waste (ashes, dirt, etc.).



How the garbage of New York city is unloaded at Barren Island.



The presses of the Barren Island garbage reduction plant.

Stains on Brick

THE brown, white and yellow stains which frequently disfigure brick buildings or walls are the result of a saline efflorescence which may sometimes be removed, according to the *Bibliothèque Universelle*, by washing with slightly acidulated water, when pure water proves inadequate. Prevention, however, is better than cure. The stains are caused by particles of soluble salts which have been carried to the surface by water and are then crystallized by evaporation. These comprise sulphates of potassium, sodium, aluminium, magnesium, and calcium, the last being the one commonest found and the one most resistant to rain. Chlorides and carbonates are also often found. These salts pre-exist either in the earth or in the waters used in manufacture, or in the mortar or sand, the latter being especially the case near the seashore, where sand from the beach is commonly used without the precaution of washing with fresh water. The entry of salts into the brick may occur during the baking, also, when the coal contains pyrites. Care should be taken to use water of low mineral content, especially as regards sulphates. Where only "sulphur water" is available it should be neutralized with a barium salt (the chloride or carbonate).

Wireless Telegraphy in Peru

WIRELESS communication has been established between Lima and Iquitos, across a vast stretch of the Andes, without the use of intermediate stations.

The Business Side of German Science—VII

Making Money With the Aid of Technically Trained Men

By Waldemar Kaempffert

[*THIS is the seventh of a series of articles, written by the Managing Editor of the* SCIENTIFIC AMERICAN, *on German industrial conditions. The author was sent abroad by the publishers for the express purpose of gathering the material on which the articles are based. In this and the article to follow, the part played by the technically trained man in German business is pictured.*

The amazing industrial development of modern Germany is to be attributed in large part to technical education and to the application of science to business. Capital and science work hand in hand. Every one of the great chemical discoveries of our times, most of them made in Germany, are the result not of haphazard experimenting, but of systematic research that has meant the expenditure of princely sums. All German manufacturing is so thoroughly saturated with science, that even the small producer practises on a miniature scale the methods of his larger rivals.]

THE notion that industrial success is largely a matter of luck dies hard. The huge American trust is a refutation of the oft-repeated fable that chance plays the largest part in business success. In Germany the evidence that conspicuous industrial success is not nowadays attained without well-directed effort, without the aid of technically trained men, is even more apparent than in America. Every prominent manufacturing firm in Germany maintains its department for industrial research.

The Wonderful System and Organization of the Germans.

The scientific work of a great German manufacturing company naturally divides itself into three classes. In one class men are to be found whose duty it is to control the manufacturing operations from a special laboratory; in another will be found men who are engaged to do research work pure and simple, for the purpose of improving existing manufacturing processes, devising new ones, or discovering new products; and finally in the third class are men who try out a new discovery on a miniature factory scale in order to determine its commercial possibilities.

Perhaps the finest example, outside of the chemical industry, of the technical control of manufacturing operations is to be found at the cast steel works of Krupp at Essen. The uniformity of the Essen products is to be attributed entirely to the rigorous scientific control of the entire cast steel plant. Each step in the manufacture of steel is checked up in the laboratory. Analyses are made by the hundred. The work has been so systematized that boys and young men do the actual work under the supervision of a chemist. Thus it becomes possible to make five hundred analyses of iron for carbon dioxide in a day. The laboratory workers simply see to it that Bunsen burners are lit, that retorts are boiling, and that filters are working properly. The supervising chemists are thus permitted to perform more important duties than that of watching a burette or a test tube. The laboratory workers are simply tools in the hands of their supervisors. They must be intelligent enough to perform the tasks assigned to them, but they must not be so intelligent that they are led to experiment for themselves. A similar method of employing intelligent workmen is followed by the United States Steel Corporation.

Research is not conducted simply by intelligent young men, but by university graduates, as may be supposed. The work is so subdivided that often two chemists working side by side may know nothing of the problem as a whole.

When after countless trials and failures a discovery is made by a research chemist that seems to have commercial possibilities, a small experimental plant is erected in which the same type of apparatus which is to be used for actual work operation, is employed. The conditions are industrial conditions. Little factories are equipped with little autoclaves, little filtering presses, little hydraulic presses, and little vats. At a great coal tar dye factory near Frankfurt I saw new dyes being tested on a small scale which involved practically the erecting of a miniature leather dyeing plant, a miniature paper dyeing plant, and a miniature textile dyeing plant. Thus the suitability of newly discovered dyes for special industries was ascertained. Upon the dozens of scientific men in the laboratories of a manufacturing company a strict masonic secrecy is imposed.

The Masonic Secrecy of the Laboratory.

It is even said that the director of one part of a great chemical works is not permitted to enter another part, and that the exact salary of an important man may not be known even to his own wife. So far is secrecy carried that a chemist in one laboratory is frequently totally ignorant of the work done in another laboratory in the same building. He is not allowed, with rare exceptions, to read papers before learned scientific societies, at least not without the consent of the firm. Buried away in the files of the great companies are probably the records of countless experiments which, if made public, would unquestionably advance the whole cause of science. The individual steps, already taken, must be painfully retraced by university professors who are working for no commercial object. At Essen, for example, I was told that the problem of gun erosion had been so far studied in the laboratory that the Krupps considered themselves ten years in advance of America on that point, but when I asked a chemist if he could refer me to any scientific publication in which the Krupp experiments are discussed, I was informed that they had not been published and probably would not be published; that they were, indeed, in the nature of trade secrets.

The Business Management of a German Manufacturing Company.

A German company is usually managed by a board, at least one member of which is a scientifically trained man, thoroughly conversant with the technical operations of the plant. One of the directors may be a lineal descendant of the original founder of the factory. He bears the name of his ancestors and continues the traditions of the old factory so long as they meet modern requirements. Another director is a glorified salesman. He is a man who has traveled much, who knows government officers, who may ultimately win the title of *Kommerzienrat* and who may even win a seat in the Reichstag. All of these men speak four or five languages and speak them well. With them on the board sit men who have represented the company in foreign countries and who travel six months in the year establishing agencies all over the world.

As a result of this partition of labor it is difficult for one man on the board to overawe the others. The purely business men know nothing of science; they must rely upon the technically informed member of the board. On the other hand, the technical director knows little of business and must accept the views on finance uttered by those members of the board who are better informed on such subjects than he. As a rule the directors are all men between thirty-five and fifty. Keen, alert, thoroughly informed of business conditions in foreign countries as well as their own, students of international politics, they are, in a word, broad-minded, cultured business men of the finest type. Even the chemists and engineers on the board of directors are essentially commercial men—commercial in the sense that they meet the mechanical requirements of the world. More, however, is required in that respect of the German than of the American engineer. The German enters into direct competition with French, German and Austrian technologists, who have at their command labor just as cheap as his and just as plentiful. We find him, therefore, thoroughly conversant with every phase of the industry in which he is employed. Nothing escapes him. He knows the source of raw material, its price both to him and to his foreign competitors, the manufacturing processes adopted in foreign countries and their efficiency as compared with his own. He studies the idiosyncrasies of the foreign market, and seeks to adapt himself to them. He knows the transportation facilities as well as any shipping agent. He makes a study of tariff schedules and customs laws of foreign countries.

These men usually have at their command a huge capital, represented by bonds and stocks valued at anywhere from five million to ten million dollars. The dye stuff industry of Germany as a whole represents an investment of about seven hundred and fifty million dollars. There are surpluses and reserve funds that amount in several cases to over two million dollars. Dividends of thirty-five per cent are occasionally allotted.

Because there is more science in German than in American industry there is less audacity. The offhand way in which many American business men will sink a hundred thousand dollars in an enterprise about which they know absolutely nothing, simply on the strength of a friend's well-meant advice, is without a counterpart in Germany. But when the board of directors of a German company has thoroughly studied a problem with the aid of competent men, when, as a result of that study, they have become thoroughly convinced that in the solution of the problem there lies a commercial possibility, money is spent freely in researches that may extend over years before it is possible to erect the first manufacturing plant. Thus the Badische Anilin und Soda Fabrik spent about four million dollars, it is said, to develop the present method of making synthetic indigo on an industrial scale. But the pecuniary sacrifices thus made were not risked for work that might or might not succeed. The result was foreseen and inevitable. The company knew that, given time, money and brains, the problem could be solved. Every path was explored, every chemical reaction that could possibly be employed was tried, with the result that every chemist now knows.

Millions for Research.

So, too, the Badische spent thousands and thousands of dollars in developing the Schoenherr process for the reduction of atmospheric nitrogen. The late Heinrich von Brunck, who did much to bring the company to its present eminence, realized how important was the solution of the problem. He placed ample funds at the disposal of Dr. Schoenherr. The Badische Company needed sodium nitrite for the production of anilin dyes. Previously, sodium nitrite had been made by the reduction of Chile nitrate with lead; but this method of production was costly. On every acre of the earth atmospheric nitrogen to the amount 31,000 tons presses; for eighty per cent of the air we breathe is composed of nitrogen. At that rate the air over every nine acres contains about two hundred and eighty thousand tons, equivalent to the amount of Chile saltpeter used in 1907. It is no easy matter to utilize the nitrogen of the atmosphere, simply because it is inert, in other words, because it refuses to combine very readily with other elements. Schoenherr devised an electrical method of fixing the nitrogen of the air, which is now familiar to the readers of this journal. As a result of the Schoenherr process, sodium nitrite is no longer reduced from Chile nitrate. Practically the entire supply of the world, valued at about one million dollars, is now obtained electrically.

So, too, the contact process of manufacturing sulphuric acid was developed by the Badische Company because of the demand of the indigo and alizarin manufacturer for a cheap concentrated sulphuric acid and sulphuric anhydrid. The demand for cheap sodium and chlorine induced the company to develop the electrolytic soda process. In a word, even the raw materials of a great industry are now made by cheap and efficient processes, scientifically developed.

The amount of work that must be done in systematically developing an industrial process along scientific lines is herculean. New methods must be worked out before a way is at last discovered of attacking the problem in hand. The work is slow because the investigator must follow an unblazed path. To spend two hundred thousand dollars a year and have nothing to show at the end of that period may seem sheer madness. Yet the German chemist knows that given time, money and brains, he must eventually succeed, knows that the commercial returns from a single great discovery are enormous. Of seventy-five research chemists whose collective salaries may vary from \$75,000 to \$200,000 a year, seventy may discover nothing, while the other five may discover products that mean a net return of a hundred thousand dollars a year for at least the life of an ordinary patent. That explains why some of the German chemical products notably drugs, seem inordinately high in price. Dr. Eberhardt of the Badische Company put the matter thus: "If capitalists are to employ inventors or to take up the exploiting of inventions as their business, as a means of earning their dividends, they must be recouped from successful inventions for the losses which they inevitably will incur from unsuccessful ones. Success can be made certain only by taking a large number of chances. A firm employs, let us say, one hundred chemists and engineers for the purpose of making and working out inventions. Some of these will never make an invention, but their salaries have to be paid. Few can be relied upon to deliver a paying invention every year, but the expense of their laboratories and their income has to be assured. If these conditions, essential for the establishment of chemical industry, were better realized, there would be less talk of the exorbitant prices charged by patentees for their product, and the ideas of many people as to fair terms for licenses—compulsory or otherwise—would have to be re-arranged."

(*To be concluded.*)

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

A Defense of the Forest Service

To the Editor of the SCIENTIFIC AMERICAN:

My attention has just been called to the letter published in the SCIENTIFIC AMERICAN for June 1st under the heading "Comment on the Forest Bill." The bias of the writer is so obvious that I consider it unnecessary to make reply to most of his assertions; but certain passages in his letter compel attention.

Forest rangers are spoken of as "apparently imbued with the sole idea of 'riding' the sheep, cattle, and other industries therein, and principally the men who drive their stock across this country, or who have previously owned for years patented land around the water therein. In this way they make a part of their salary, while the rest comes out of the general Government."

This passage is so worded as to suggest that rangers are in the habit of levying on stockmen and others for their own personal benefit. What are the facts? The stockmen who graze their sheep and cattle on the National Forests pay the Government for the privilege, although they pay much less than it is worth and much less than they pay in the same regions for the same privilege on privately owned lands of equal grazing value. But all receipts from users of the forests are covered into the Treasury of the United States, while the salaries of all forest officers are paid entirely from the annual appropriations for the Forest Service made by Congress.

The writer also says:

"I think much money is now being unlawfully diverted and should be curbed, and wish you would interest yourselves in the matter further.

"If you want specific instances, I will furnish them."

I should certainly be glad to learn of any instances, specific or otherwise, of unlawful diversion of public funds.

It is one thing to criticise the national forest policy, concerning which there are bound to be honest differences of opinion and which, from the fact that it collides with the private interests of many individuals, is bound to be warmly debated; but it is quite another thing to indulge in reckless accusation of public officers. If I have allowed public funds to be mis-spent, I should be removed from my position. If forest rangers have been taking advantage of their position to practise extortion upon users of the national forests, they should be in jail. The writers of letters like the one which you published should, as a matter of public duty, lay their evidence before the officers who have power to institute criminal proceedings or to take the proper disciplinary action; or else they should retract their statements. There is no finer or more devoted body of public servants to be found anywhere than the men of the Forest Service, and in justice to them I cannot but protest vigorously against such imputations as your correspondent seems to wish to convey.

H. L. GRAVES, Forester.

United States Department of Agriculture, Forest Service, Washington, D. C.

[The letter of June 1st referred to by Mr. Graves was published without prejudice on our part, and we take much pleasure in presenting the above reply.—EDITOR.]

Maritime Canals and Restrictions on Size of Vessels

To the Editor of the SCIENTIFIC AMERICAN:

The SCIENTIFIC AMERICAN of even date is before me. On page 579 you have an item referring to Mr. Grunsky's report in reference to maritime canals and restrictions on the size of vessels. In order that your readers may be informed, I may say that Mr. Grunsky's recommendations were not approved. All the writers of the various reports, from several maritime nations, of which Mr. Grunsky was Reviewer, and who were present and some who were absent but were represented, unanimously protested against his "Conclusions," considering it to be the work of the International Navigation Congress to *promote* instead of to *restrict* navigation.

Mr. Grunsky presented five suggested "Conclusions," four of which were not accepted. The fifth was adopted as the sense of the Congress, which simply stated that a maritime canal should be five times as large as the immersed portion of the largest ship which is to use it, with a depth of one meter under the keel, these values being functions of the speed and somewhat of the volume of commerce, and are to be determined by local conditions.

ELMER L. CORTHELL, D.Sc.,
President Maritime Section of the Congress.

Bow Rudder for Ships

To the Editor of the SCIENTIFIC AMERICAN:

As many of the notable advances in various fields have been accomplished by a process entirely at variance with the customary and accepted way of doing things, I think my suggestion may not be as quixotic as it may seem at first glance. My idea is that a rudder should be at the bow of ocean steamships, in addition to the present one at the stern. If the "Titanic" had been so equipped, she would no doubt have been afloat to-day. The "Hawke" disaster would most surely have been averted. Let us follow the action of a rudder placed at the stern. If the bow is approaching an object, the action of a stern rudder is to swing the stern in the same direction as the object, and the bow is then pointed away, but before a rudder can point a boat away from any obstacle, the whole ship has been swung closer to it, which is the reason that it is difficult for a boat to swing directly away from alongside a wharf. Now let us follow the action of a rudder placed at the bow: On approaching an obstacle, the rudder would be turned away from the object, and would pull the bow of the boat directly away from it, and the ship would track after it, the same as an automobile does in turning a corner. In the case where the smaller boat was caught in the suction alongside a larger one, a bow rudder would have turned the bow away immediately, instead of which the stern rudder simply swung the stern of the boat in as well as the bow toward the larger boat. In the case of the "Titanic" a bow rudder would have drawn the bow aside immediately, instead of which the stern rudder in that case simply threw the ship partially broadside on the obstruction. Now this idea of placing a rudder at the bow will doubtless be criticised, and one of the first will be the objection to its exposed position. The rudder would not be damaged unless the ship runs into something bow on, a trick not appreciated by good seamen. Of course, the rudder would have to be hung somewhat differently from the stern, so that about three-fourths of it would follow the post, but I think it would be a simple matter to arrange the necessary details.

Toronto, Ont. A. C. LAWRENCE.

A New Phonograph

To the Editor of the SCIENTIFIC AMERICAN:

May I point out that the sound-recording apparatus of Mr. Lifschitz, described in your issue for April 27th, is not as novel as you seem to think it, as Mr. J. C. M. Stanton, Mr. R. C. Pierce, and myself constructed an exactly similar apparatus more than ten years ago. The greater portion of this apparatus still exists in my possession, as also one of the photographic records from which the reproducing strip was prepared, together with some of the latter.

As a delineator of the complicated curves which represent human speech, we found the photographic recording apparatus most efficient; but as a reproducer of sounds the system was not nearly so effective as the auxetophone of Sir Charles Parsons, which also operates by controlling the emission of air from a charged reservoir. Furthermore, the great length of ribbon that was required made the records unduly bulky.

London, England. A. A. CAMPBELL SWINTON.

The Fatal Aeroplane Accident at Boston

THE third Boston Aeroplane Meet, which was held from June 29th to July 7th, had a pall thrown over it at the close of the third day by the sudden death of its manager, Mr. W. A. P. Willard, and Miss Harriet Quimby, America's best-known aviatress.

The accident occurred at the close of a 20-minute flight to the Boston Light and back, which had been accomplished in a perfect manner by the skillful aviatress. She had risen, when at the farthest point, to a height of some 2,000 feet, and had been gradually descending all the way back. She had almost reached the field, and was at a height of about 1,000 feet, when the machine made a sudden dip and the body of her passenger, who had been seated in the rearmost of the two tandem seats, was thrown out of the machine and came hurtling to the earth. For a moment the pilot managed to right her machine, but the next instant it dived vertically and almost turned upside down, the result being that she too was thrown out, despite the strap which she had placed across the fuselage just in front of her waist.

As the two bodies fell with terrific speed and struck the water where it was only a yard deep, the aeroplane continued its plunge, but soon righted itself so that it descended at an angle of some 65 degrees and, striking in shallow water, turned upside down and remained on its back not severely damaged.

It is hard to find a plausible explanation of this terrible accident. Miss Quimby had flown her powerful 70 horse-power Blériot not more than half a dozen times, but she had never experienced any difficulty in managing it. On her first flight at Mineola, she used ballast in the shape of sand bags in the passenger's seat. She complained of the shifting of the sand, which she could feel when in flight, and afterward she never flew except with a passenger. Her machine was the latest military-type Blériot and she believed it perfectly safe as far as carrying a passenger was concerned, because the latter, being located some 4½ feet back of her own seat, could not interfere with her in any way—as had happened when the seats were side by side, with almost disastrous results.

As in the case of Moisant, who was flung from his machine as was Mr. Willard, the most plausible explanation of the accident seems to be gyroscopic force. A very slight difference in pressure against the front edge of the wing (which might be caused by a sudden turn of only a few degrees, occurring as a result of an "air hole" or of the pilot's foot slipping off the tiller) would, with the heavy 70 horse-power Gnome motor running at full speed, as it apparently was doing, develop a powerful and sudden force that would turn the machine instantly downward and whip the tail around through the arc of a circle so quickly that it might even break the fuselage. Eye witnesses agree that Willard was flung aloft and forward as from a sling, his body falling very close to the plunging machine, if, in fact, it did not hit the latter in its descent. This terrific gyroscopic force acts much more quickly and powerfully than does the force of gravity itself. Even a heavy, rapidly-revolving propeller on a non-rotary motor engenders sufficient gyroscopic force to put the aviator on his guard. In all probability many of the terrible accidents which have occurred with revolving-cylinder motors have been due to this unrecognized force, which takes the aviators unawares.

After Willard was pitched out, it appears to have been impossible for Miss Quimby to maintain the equilibrium of the monoplane sufficiently to make a safe descent. That she tried her best to do this, and that she succeeded for a moment, is seen in the fact that the aeroplane straightened out after its first dip and before its final plunge. It is also possible that the control post became jammed, owing to Miss Quimby reaching forward for something, or that it was thrown suddenly forward sufficiently to make the initial dive in this manner. It was in this way that Moisant made a sudden plunge to earth at Belmont Park one time when he was reaching forward to turn on the oil. There is also the possibility that a control wire may have broken, but as these were in duplicate this is very doubtful.

It is possible that a so-called hole in the air may have caused Miss Quimby's accident. The writer has a vivid recollection of seeing Earle Ovington suddenly tip to one side at an angle of 45 degrees when he experienced such a downward current over the edge of Long Island Sound at Bridgeport, Conn., over a year ago. Ovington saved the situation by diving, but he said when he alighted that had he not acted with the greatest celerity, and had he not been strapped in securely, he would have fallen to his death. The aeroplane in this instance tipped with great suddenness, one wing of the machine evidently passing into a swiftly descending current. In Miss Quimby's case, from the accounts of eye witnesses, it seems to have been a forward dive that pitched out the occupants of her machine.

Might it not be possible that this sudden dive was caused by the aeroplane striking a fast downward current head-on, even though it were going 70 to 80 miles an hour? At all events, such currents of air seem to be most numerous above the coast line, and aviators should be very careful when passing over it.

Miss Quimby, as the readers of the SCIENTIFIC AMERICAN are aware, had been flying for something less than a year. She learned to fly at the Moisant school at Mineola, under the tutelage of André Houpert; and only a day or two before she left for Boston, her former instructor had endeavored to persuade her to give up flying, as her sister aviatress, Miss Matilde Moisant, has done. She believed in the safety of the aeroplane if flown with discretion (and she never flew it otherwise), and it is certain that the accident which caused her death was not due to fancy flying or faulty manipulation of the machine by her in any way. Miss Quimby was the first woman to fly across the English Channel, a feat which she performed on April 16th last, as already described in these columns. She was a self-made young woman, of gracious personality, who had endeared herself to the staff of *Leslie's Weekly*, of which she was a member, and to every one in the aviation fraternity. Miss Blanche Scott, the only aviatress we have remaining, was flying at the Boston meet at the time of the accident. She did not give up on account of it, but continued to fly every day until the end of the meet.

Destruction of the Airship "Akron"

Vaniman's Career and Tragic End

The airship "Akron" on one of its trial trips maneuvering close to the water.

AMERICA'S only airship vanished in a flash of smoke at 6:38 in the morning of July 2d, and with it perished America's only aeronautic engineer with his crew of four men. The accident, although viewed by three thousand spectators along the shore of Atlantic City, will ever remain a mystery; for not a soul aboard the vessel survived. Eye-witnesses of the disaster speak of a wreath of smoke that appeared, followed by a caving in of the gas-bag. An instant later there was a loud explosion that burst the envelope, and the car dashed down into the sea, where it fell a heap of wreckage in water a few feet deep.

The cause of the disaster is open to conjecture. It seems to be the general opinion that it was due to rapid expansion of gas under the heat of the sun, although it is not clear that there was much variation in temperature while the airship was in flight. The "Akron" was brought out at 6:15, and took to the air without mishap. Apparently everything was running smoothly and a number of maneuvers were executed successfully. After a time it was seen to rise to a considerable height, and it was apprehended that Mr. Vaniman was having difficulty in bringing the dirigible down. Possibly, and this is a mere surmise, Mr. Vaniman attempted to bring the airship down by pumping air ballast into the ballonets. Possibly he had miscalculated the strength of his envelope, or his pressure gages may have been incorrect or else his safety valve may have jammed. At any rate, it is probable that a serious leak developed and that the hydrogen was touched off by the redhot exhaust gases from the engines.

When the "Akron" was being built last fall, great secrecy was preserved concerning the fabric employed. Every scrap and clipping of the material was carefully preserved and kept from the hands of souvenir seekers. It came out afterward that Mr. Vaniman placed great hopes in this fabric; for it had been made many times stronger than the ordinary fabric used in a dirigible balloon. He hoped thus to prevent expansion of the balloon with every slight variation in the temperature of the gas and to obviate the necessity of releasing gas when the balloon arose into the rarer atmosphere of higher levels. When the "Akron" received its first test in the flight of November 4th, last year, Mr. Vaniman found that this principle was correct and he succeeded in making the dirigible rise and fall by subtracting or adding to the air ballast he carried in his ballonets. For instance, if he wished the machine to come down, he would pump air into the ballonets, compressing the gas and making the balloon heavier without increasing its displacement. His idea then was to pick up water ballast from the ocean in what he called a "hydro-levator." Although the flight ended in a mishap, the experiments were successful and led Mr. Vaniman to the invention of the "wire wound" dirigible balloon, that is a balloon made of a fabric reinforced with steel wire.

A description of this balloon appeared in our issue of February 17th. The idea was to use, with the cotton thread, steel piano wire no thicker than the thread, weaving the two together in a loom of special construction. The wires were to be of continuous length from end to end of the balloon and the fabric was to be laid on in two layers, one running longitudinally and the other spirally about the balloon. By placing the wires a tenth of an inch apart in one of the layers and a twentieth of an inch apart in the other, he was able to make a fabric so strong that it would resist a pressure of 52 inches of water against 1½ inches of water in the "Akron," and less than half an inch of water in the ordinary balloon. Thus by making the bag thirty-five times stronger than that of the "Akron" he would be able to prevent it from expanding even though the temperature of the gas within rose fifty Fahrenheit degrees. On an airship of the size of the "Akron," the weight of the steel wire would have added about two and a half tons, but this would have been a small price to pay for the absolute stability obtained. It would then be a simple matter to bring the dirigible down by pumping air into the ballonets and then to raise the dirigible by releasing the air from the ballonets. The task of constructing such a balloon is no small one, and many problems arose, but Mr. Vaniman showed remarkable ingenuity in solving them. We are informed that he had ordered a loom and was about to begin the actual construction of the new balloon at Atlantic City when the disaster occurred.

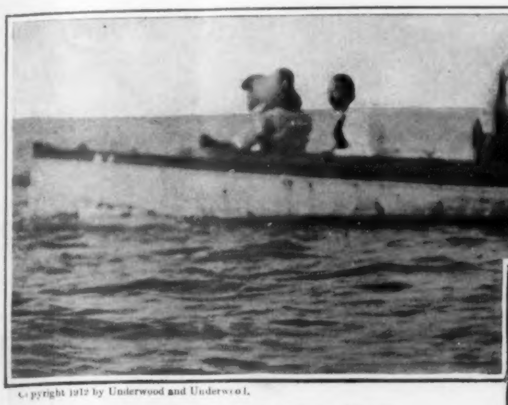
The "Akron" was the first American-built dirigible balloon to compare favorably with the highly advanced practice in Europe. All our other dirigible balloons have been mere toys in comparison. The Wellman airship was not an American-built vessel, but was first constructed in France for the Arctic expeditions, and then merely reconstructed in this country for the transatlantic venture. The "Akron," however, may be considered the first and only airship worthy the name that this country has ever produced. It was 258 feet long, 47 feet in diameter, and had a capacity of 400,000 cubic feet. It was provided with three engines, two of 100 horse-power and one of 80 horse-power, which were designed to propel the craft at a speed of 30 miles per hour when all three pairs of propellers were operating at the same time. The two after pairs of propellers were arranged to be swung about at such an angle as to drive the airship up or down as desired. In addition to this there were planes fore and aft which could be used for steering the vessel vertically. As in the Wellman airship, the car was built in contact with the under side of the gas bag instead of being separated by a considerable space, as in all other types of non-rigid dirigibles. This served to stiffen the structure, but brought the highly inflammable hydrogen into close proximity with the engines. Possibly this daring design may have been the cause of the disaster.

Melvin Vaniman met his death in the prime of life, at the age of forty-five. He was born at Virden, Ill., near Springfield, on a farm. His father, an Ohio man, was one of the pioneers who opened up that section. The first sixteen or seventeen years of Vaniman's life were spent upon the farm; subsequently he went to college at Mount Morris, near Chicago, and at Valparaiso, Ind. He then took up the study of music at Chicago, and was for a time active on the stage as an opera singer. It was upon these operatic tours that he began to carry a camera with him, which, as events subsequently turned, strangely enough proved to be the first cause of his entering the field of aeronautics.

This opera company with which he was traveling made a western tour to San Francisco and Honolulu and was overtaken by ill fortune, a plague scare having broken out in Honolulu, which so affected the commercial situation that the company was dissolved. Mr. Vaniman, therefore, looked about him for some business opportunity, and his services were engaged by a steamship company, which took him on one of its tours to prepare photographs of the scenery *en route*. In this way Vaniman visited New Zealand. Here he prepared photographs for the New Zealand Tourists' Department, and his collection was of such excellence that it was exhibited at the St. Louis World's Fair, and received a gold medal, the highest award. Vaniman had constructed a special camera for his work, which enabled him to prepare very large, panoramic pictures. It is this camera which, by a peculiar trend of events, proved the first cause of Mr. Vaniman's interest in balloons. In order to obtain his pictures he was forced to seek out elevated points which were often not easy of access, such as the tops of trees, masts and similar inconvenient places. He, therefore, conceived the idea of making use of a captive balloon for his purposes. This plan took him to London, Paris and Rome. The captive balloon, however, still had this inconvenience; it had to be launched from the neighborhood of gas works. An obvious way to overcome this difficulty would have been to employ a dirigible air-craft. Hence, Vaniman, with his resourceful mind, turned his thoughts to the construction of aeroplanes, upon which he worked for some time, finally turning out a machine which proved to be ill-fated, and was completely destroyed in one of the trials, in landing.

The next event of interest to be chron-

The "Akron" emerging stern first from its hangar.



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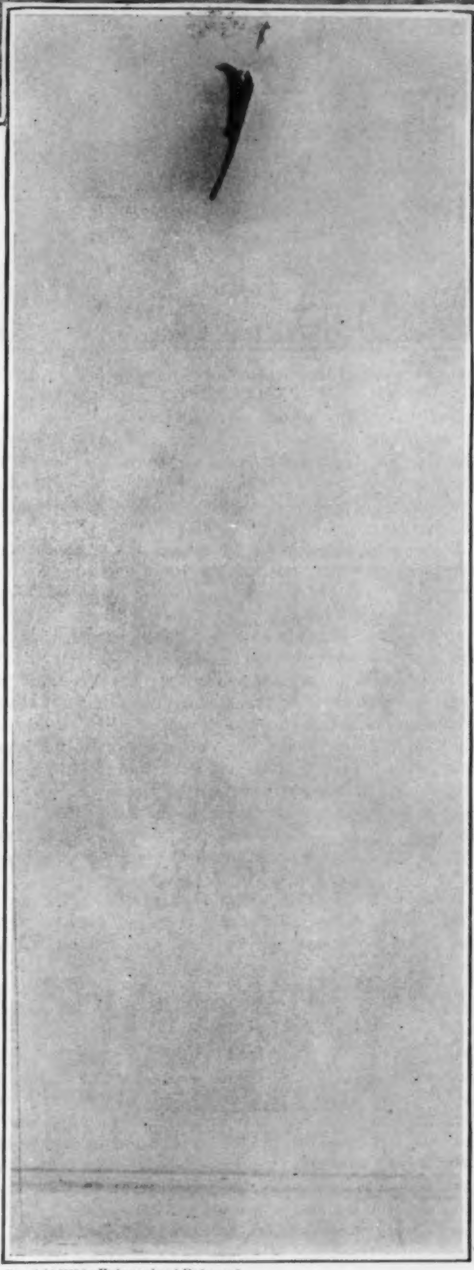
Examining the wreck of the "Akron".



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The disrupted envelope falling to earth.

The gas bag afloat at Absecon Inlet.

icied in Vaniman's life is his introduction to Mr. Wellman, who had just finished his first polar campaign and was preparing for a second. Offers of plans for a dirigible balloon for the second expedition were called for, and Vaniman's designs were the ones chosen and he himself appointed chief engineer. He went north in 1907 and spent the summer building the balloon. Two trips were made with this balloon; the first time the crew was lost in a snowstorm, and landed in a glacier. The second trip was hardly more successful, and was brought to an abrupt and early conclusion by the tearing off of the equilibrator, which in this instance was ballasted with food and provisions for the party. The expedition, therefore, had to be abandoned. Peary's discovery of the North Pole put an end to further attempts at Arctic airship expeditions, and the next venture was the Wellman transatlantic expedition.

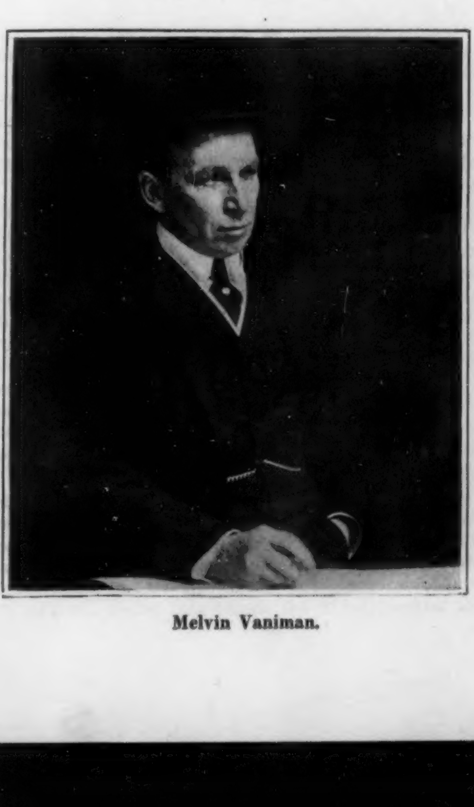
The crossing of the Atlantic by airship has seemed such a foolhardy undertaking that the public has been inclined to consider Mr. Vaniman a mere reckless adventurer. He was more seriously taken when he actually made the attempt. The public was quick to grasp the fact that Mr. Vaniman was the moving spirit in this expedition and the engineer to whom all credit for the partial success was due. The attempt was not an utter failure. The "America," as the airship was called, stayed in the air 71½ hours, establishing a record for dirigible balloons, and covered 1,008 miles, which was also a record. The equilibrator, or floating drag, retarded the airship to such an extent that it could not keep up with the winds that were carrying it across the Atlantic, and yet without the equilibrator the airship surely would have been lost on the third day out. As was stated in the SCIENTIFIC AMERICAN at the time, when the "America" was abandoned it was structurally just as sound as when it put out from Atlantic City, except that one of the propellers was disabled.

When a member of the editorial staff of the SCIENTIFIC AMERICAN visited Mr. Vaniman after his rescue from the "America," and questioned him on the object of such a venture, Mr. Vaniman was careful to explain that it was not from choice that he had undertaken the trip. He felt that the dirigible balloon was being entirely neglected in this country, and that it ought to receive far more attention than the aeroplane. He knew that only by accomplishing something of a startling nature could he arouse his countrymen to the value of this form of aerial navigation, and he stated that if he could arouse equal interest in some other way, he would rather do so. He realized the hazards of navigation in a dirigible balloon, but was sure that they would yield to study and experiment. When the idea of wired fabric occurred to him he was confident that the problem of safety in the air was solved at last. He never made extravagant claims for aerial navigation. He did not believe that the dirigible balloon could ever be used for transporting mail or express matter or for carrying people from place to place on scheduled time; since so much depends upon the direction of the wind. However, he did expect to see the time when stable wire-reinforced balloons would be used for pleasure trips and vacation tours. It is a pity that his life was not spared to complete this new balloon and demonstrate its usefulness. We are inclined to believe with him that it held out unusual promise of success, and unfortunately there appears to be no one else in this country with the ability and experience to carry on his work.

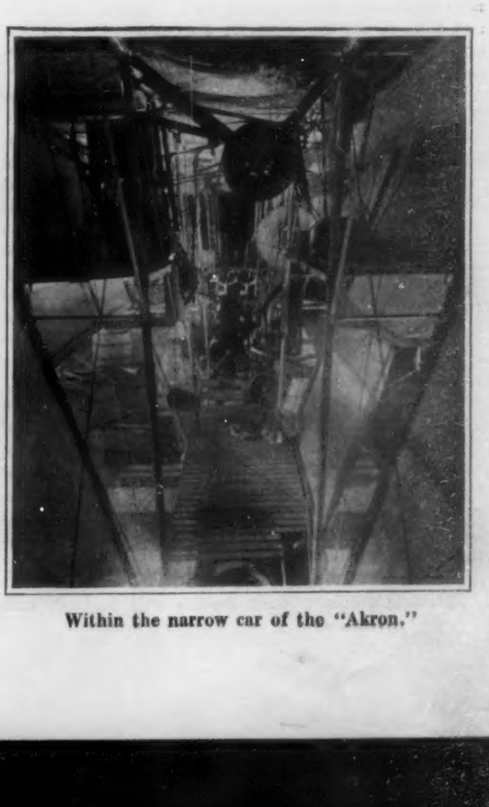
Radio-activity of Human Organs

DR. COARNS, of the Heidelberg Institute for the Study of Cancer, has succeeded in obtaining experimental evidence of the radio-activity of various human organs. The first experiments were made by allowing the organic matter to act, through a wire grating, on a photographic plate wrapped in black paper. Faint radiographs were obtained by twenty-four hours' exposure, the strongest action being exerted by the substance of the brain. In order to prove that the observed effects were really produced by radio-activity of the organic substance, portions of the brain, heart, liver, spleen and lungs of twelve cadavers were incinerated and their radio-activity was tested with Becker's emanometer, by measuring the rate at which the electrometer of the apparatus lost its charge under the influence of the incinerated substance. In most cases, one gramme of the substance produced more or less conductivity in the air. The brain was found to be the most strongly radio-active organ. A surprisingly great effect was produced by the incinerated brain of a person who in life had drunk large quantities of radio-active water for the alleviation of abdominal pains. The kidneys and the spleen were uniformly found to be the least radio-active of the organs examined, and the liver and the heart also showed little radio-activity. In two cases the substance of the lungs was tested, and was found to possess a comparatively high radio-activity. The number of measurements is too small to allow definite conclusions to be drawn.

Walter Bourillion, assistant navigator, at the wheel.



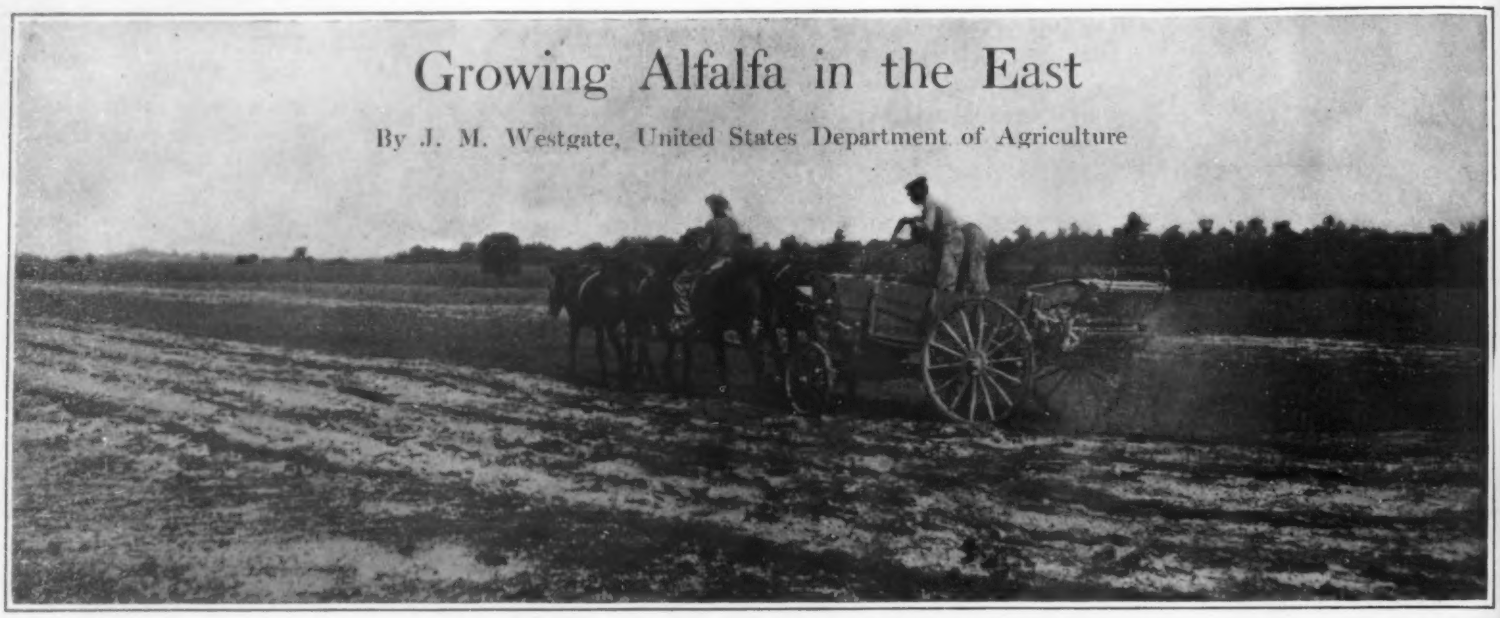
Melvin Vaniman.



Within the narrow car of the "Akron."

Growing Alfalfa in the East

By J. M. Westgate, United States Department of Agriculture



The soil receiving a heavy application of lime required for alfalfa growth.

ALFALFA, perhaps the oldest of all our cultivated forage or hay plants, has had a history scarcely less interesting than that of the many nations which have utilized it. Such nations have prospered almost in direct proportion to the extent to which they have used it. The name "alfalfa" comes from the Arabs and means "the best fodder," and in fact it appears to have originated in Media or in some adjacent country, as the folklore tales from lands on different sides of this area point toward Media as the place whence it came. Although in its original state it must have had a narrow range of adaptability to varying climatic and soil conditions it has by successive stages come to be adapted to portions of every continent. Even in this country it grows below the sea level in southern California, where the climate is among the hottest in the world. In Colorado it may be seen in full vigor at altitudes above 8,500 feet. In latitude it is equally cosmopolitan and may be found growing from Mexico to Canada as well as in tropical America. The eastern half of the United States has presented a serious combination of circumstances working against its successful production. A brief survey of its early history and migrations may assist in explaining some of the reasons why the culture of alfalfa in the East has met with so many difficulties and why so many points must be safeguarded to assure success.

Alfalfa in Ancient Times.

The wars of the Persian Invasion of Greece took it to the latter country about 500 B. C., it being the custom for the advance emissaries to precede the army and to plant fields for the sustenance of the herds which helped support the invading hosts. From Greece it advanced to Italy and Spain by successive stages and was taken to Old Mexico by the Spaniards about 1519 A. D. From here it was carried to South America and later (1854) entered California through the Golden Gate at the time of the activities incident to the discovery of gold in that State. Thence it spread over the irrigated sections and more recently has continued its march eastward until now it is by far the most important forage crop of such States as Nebraska and Kansas, the latter having approximately a million acres as compared with a very few thousand two decades ago.

The eastern march of alfalfa halted, however, when it encountered the humid belt beginning with Missouri and extending eastward to the Atlantic ocean. Alfalfa was developed under scorching suns and in sections almost devoid of natural rainfall and the unnatural conditions presented by a country where the rainfall is at all excessive constitute a great handicap to its successful production. The increased rainfall causes most soils to be poorly drained and these are usually sour or "acid" in character. Both the poor drainage and acid condition of the soil prove harmful to the plants. This is by reason of the prevention of the growth of the nitrogen-gathering bacteria which are so essential to the welfare of the alfalfa plant itself and which enable the roots to accumulate vast stores of the costly nitrogen from the air, free of charge to the farmer. As has been said these bacteria not only work for nothing and board themselves, but they actually pay something for the privilege of living. They must, however, have the proper soil conditions and these are not naturally present on the ordinary farm in the Eastern States.

Requirements of Alfalfa.

Alfalfa requires a deep, fertile, well drained, well limed, thoroughly inoculated, acid-free soil. This list of requirements is long, but it means a great deal to the ordinary farmer, who usually is unable to immediately provide these conditions for alfalfa. In order to emphasize the necessity of each of these, it is necessary to treat them somewhat in detail.

A deep soil is necessary by reason of the great root development which the alfalfa plant makes. In the West the plants have been known to send down long roots for more than 30 feet into the deep, friable, alluvial soils. It is not able to make its normal growth and compete with the surface-feeding weeds if there is not present a soil sufficiently deep for its roots to penetrate and draw up the hidden stores of plant food which are necessary for the numerous crops of nutritious forage and which are out of the reach of the less deeply rooting plants. At least four feet of good soil is usually necessary unless the underlying formation be limestone, in which case, three feet has been found to suffice. The plants will, however, utilize the ground to a much greater depth if opportunity is presented for them to do so.

A fertile ground is necessary, since the hay it produces is among the richest we have and calls for the extraction from the soil of large amounts of plant food. It is a mistake to think that because it is a legume and has the power of adding nitrates to the soil that it can be seeded on land poor in the other essential elements of fertility. It cannot add phosphoric acid or potash to the soil on which it grows; and yet it requires large quantities of these elements in order to produce paying crops of hay. This fertility may be brought into the soil by the use of green manures, commercial fertilizers or by the application of a liberal dressing of barnyard manure. The last method has been found to be usually the most satisfactory as, apparently, the manure offers the conditions required by the bacteria which live on the roots of the alfalfa.

A well-drained soil is essential as the roots can not stand lack of drainage, nor can the bacteria which ordinarily live on its roots, exist in the absence of a well aerated soil.

Liming is necessary on all soils deficient in this mineral, as in the presence of acid conditions neither the bacteria nor the alfalfa itself can succeed.

It is also necessary to have the soil thoroughly inoculated with the nitrogen-fixing germs in order that each plant may be well provided with these organisms for abstracting the nitrogen from the air and converting it into a form available to the alfalfa plant.

A weed-free soil is desirable, especially a soil free from perennial weeds which cannot be eradicated by mowing. The annual weeds may be best avoided by seeding the alfalfa in the late summer which allows the plants to attain a fair size before winter. The stand of well grown plants the following spring will do much toward preventing the development of any freshly germinated weeds. It would, therefore, appear that it is possible to raise alfalfa in many parts of the Eastern States, in case proper attention is given to the selection and preparation of the ground. A number of years may be required to develop a poor field to the proper richness to hold the stand of alfalfa.

On account of the rather peculiar and exacting requirements, respecting soil and fertilizers, as well as the high price of the seed, alfalfa is not what may be called a "poor man's crop;" neither is it a crop for a run-down or unfertile farm. Its present uncertainty on many types of soil should also retard the man of limited financial means from going into its production on an extensive scale at first.

It is suggested that an experimental acre be established and divided into a number of subdivisions. Each subdivision should be given a different treatment as regards fertilizing, liming, time of seeding, rate of seeding and preparation of the soil. Each one of these plots will answer at least one question regarding the effect of a particular method of treatment. In this way the information which would otherwise require a number of seasons to procure, can be obtained at the end of the first year. The treatment proving best adapted to the particular conditions present can be applied to a larger area the succeeding season. In this way alfalfa can, if shown to be adapted to an individual farm, become established on that farm at the least possible risk to the owner or worker of the ground. The first seeding will usually furnish an abundance of soil for inoculating the subsequent seedings of alfalfa. This utilization of soil from one's own farm avoids the danger of introducing weeds and plant diseases from other sections.

Enemies of Alfalfa.

Weeds as might be expected constitute, perhaps, the worst enemy of alfalfa, and among these crab grass probably ranks first. Alfalfa does not make a vigorous growth during the midsummer in most parts of the East, and it is during this season of the year that the crab grass and other weeds make their most luxuriant progress. Unless there is an abundance of plant food in the soil to produce a luxuriant development of alfalfa the plants are apt to become soon reduced in vitality as to be unable to resist the crowding of the weedy grasses; so much so, in fact, that they may not be able to make a sufficient recovery for the succeeding season's growth. The weeds must be controlled. This is best accomplish by seeding the alfalfa in the late summer or early fall on land that is comparatively free from weeds and has been rendered even more nearly free from weeds by repeated harrowings; and, second, by maintaining the alfalfa in a sufficiently vigorous condition so that the weeds will be unable to obtain a foothold in the field. In actual practice it is seldom possible in the East to hold a stand of alfalfa for more than three or four years owing to the vigorous incursions of the more aggressive weeds. On limestone soils blue grass is very apt to crowd out the alfalfa plants. On other soils crab grass seems to take front rank among the alfalfa enemies. Plant diseases are always preying on alfalfa. These are especially troublesome when the vigor of the alfalfa is reduced by growing in soil not perfectly adapted to it.

Spring Seeding Versus Late Summer Seeding.

Much money and effort has been and is still being wasted by seeding alfalfa at the wrong season of the year. Many experiments have indicated that spring seeding, except in the extreme North, is a dangerous practice. The young plants are of a slow growth at first and as a consequence are easily crowded out by the more aggressive weeds in the late spring and early summer. The seeding should take place the middle of August in the latitude of Maryland and Virginia. Every hundred miles north calls for the seeding to take place one week earlier, while for every hundred miles south the seeding should be delayed for one week. If the land has been plowed and frequently harrowed for six weeks or two months before seeding, the plants will frequently produce a growth of ten to twelve inches before cold weather. This comparatively heavy

growth of alfalfa checks the growth of the winter growing weeds while the alfalfa plants are of sufficient size to make a rapid growth the next spring, and under ordinary circumstances will keep ahead of the weeds until the first crop is harvested. It is not usually possible north of the Potomac or Ohio rivers to turn under grain stubble in time for the middle of August seeding of alfalfa. A crop of early potatoes, however, can usually be removed in ample time for the seeding of the alfalfa since the ground does not require replowing and no time is lost in waiting for the ground to settle sufficiently to permit planting.

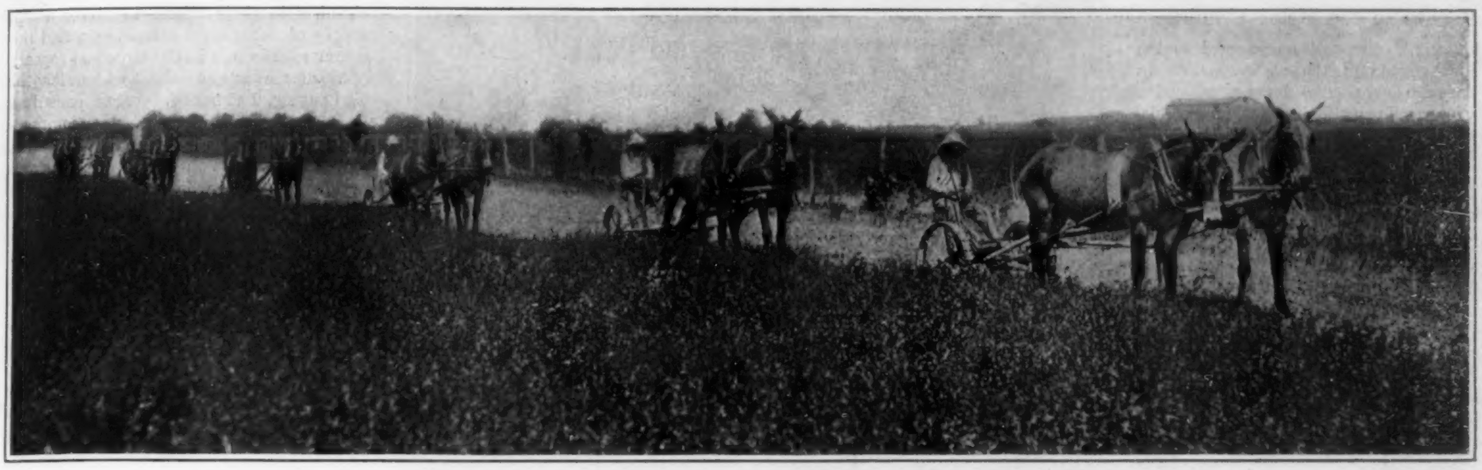
Harvesting the Alfalfa Crop.

Alfalfa gives several cuttings during a season. Every cutting should be made just as the crown of basal buds are starting the growth of the next crop. This will usually happen just as the plants are coming to bloom, at which time they range from 14 to 40 inches in height. The hay should be cured without shattering any more of the leaves than is absolutely necessary. The leaves are by far the richest part of the feed and every effort should be made to retain them. The hay is raked into windrows as soon as the leaves are well wilted and before they get so dry as to shatter. The hay should lie in the windrow until the leaves are dry and the stems still green, when it should be placed in shocks and allowed to cure before being placed in the barn or stacked.

Value of Alfalfa for the Dairyman.

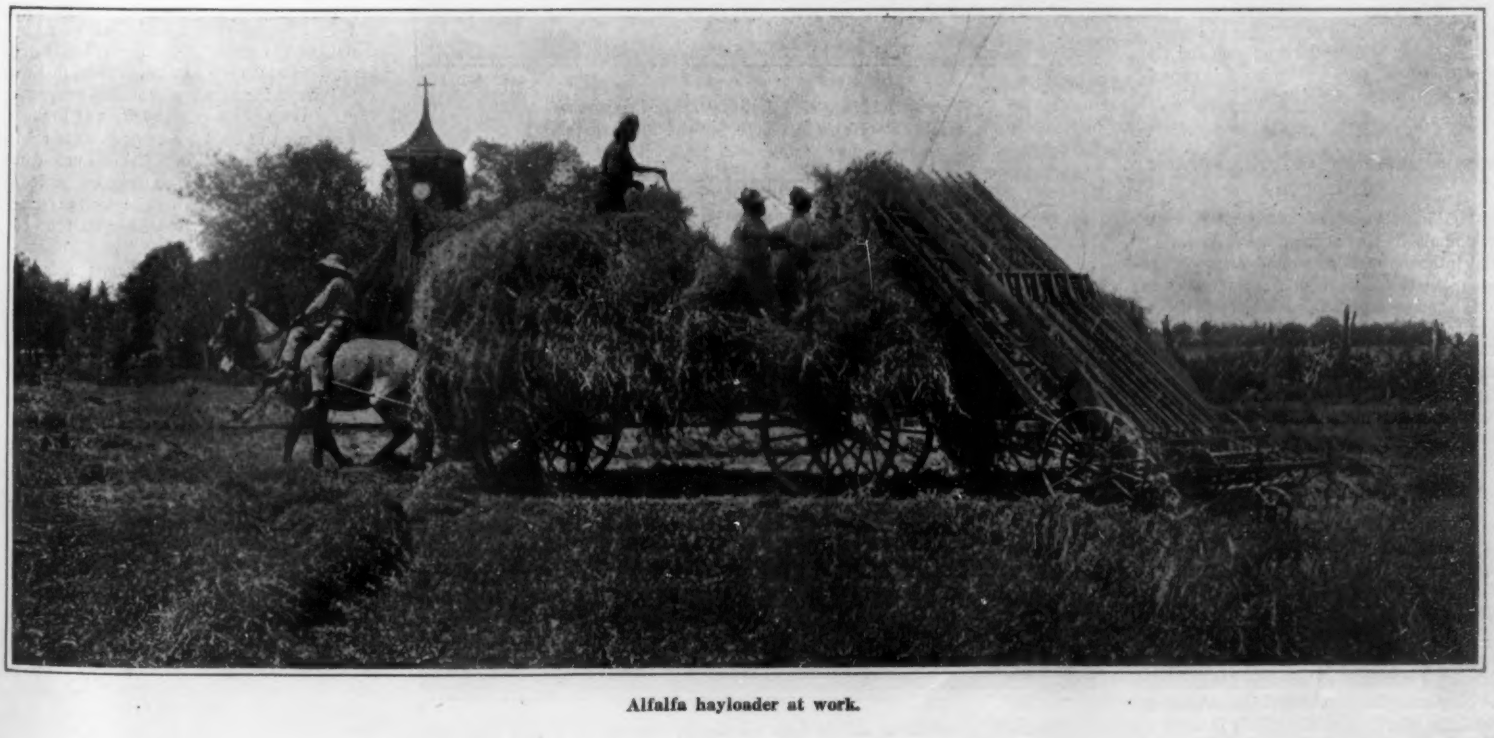
Alfalfa is a friend of the dairy farmer by reason of the marked effect of alfalfa hay on the production of both milk and butter, and also by reason of the excellent effect of the manure from the cow stables upon the growth of this really wonderful forage plant. It is for dairy farms especially that this crop is recommended in the Eastern States. Here, with an abundance of good barnyard or stable manure, the fertilizing bills are greatly reduced, while the cost of concentrates, which usually eat into the profits of the dairy farmer, is reduced to a minimum. With plenty of alfalfa hay for feed it is usually unnecessary to feed any of the high-priced concentrates in order to maintain a profitable flow of milk throughout the year.

The following ten commandments regarding the culture of alfalfa are important for the prospective alfalfa



Mowing alfalfa in a one hundred-acre field on a Virginia farm.

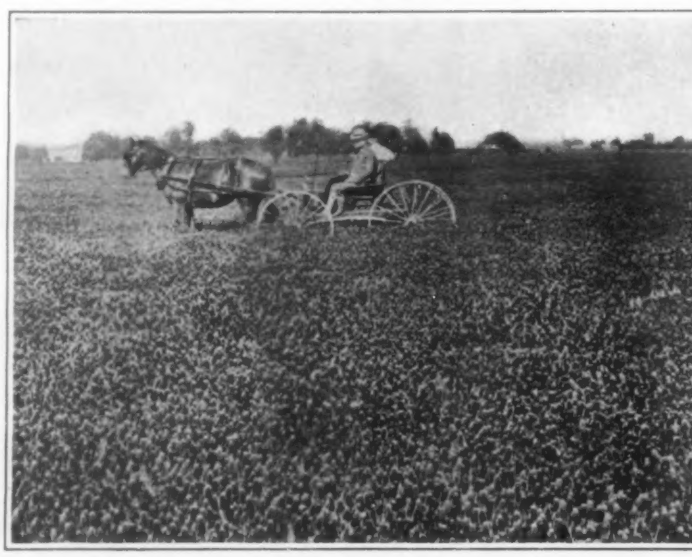
Inoculation is necessary. Here the harrows cover the soil from some old alfalfa field before the sun's rays can harm the germs.



Alfalfa hayloader at work.

grower to consider: Don't fail to provide for ample inoculation; soil from a healthy weed-free alfalfa field is best. Don't sow poor or weedy seed. Don't sow on a weedy soil. Don't sow on any but a sweet, well limed soil. Don't sow on poorly drained soil. Don't sow on any but a finely prepared, well-settled seed bed. Don't pasture the first or second year. Don't lose the leaves; they constitute the best part of the hay. Don't seed a large acreage to begin with. Experiment on a small area first. Don't give up. Many prominent alfalfa growers finally succeeded only after many failures.

Large hay forks unloading alfalfa a quarter of a ton at a time.



Crimson clover is often used to turn under for enriching the land and bringing it up to alfalfa pitch.

The use of large side delivery rakes leaves the fresh cut alfalfa in shape for the hayloaders.

Removing soil from an old field for use in inoculating a new one.

Pedesis in the Metal Uranium

RECENT discoveries in regard to the movements of the alpha particle in radioactive substances have awakened a new interest in an old phenomenon, pêdesis, or the Brownian movement. In the pollen grains of plants there are fine granular particles called *fovilla* which are set free when the pollen is crushed, and under a high power microscope they exhibit a movement which originally was believed to be analogous to the motions of the spermatozoa of animals.

But in 1827 Dr. Robert Brown observed that many inorganic substances in a fine state of trituration similarly behave.

The movement is chiefly of an oscillatory nature, but the particles also rotate backward and forward, on their axes, and even dart above the field with a rapidity depending, of course, upon the power of the objective. Pumice stone, kaolin, gamboge and finely divided clays show the phenomenon very well, but they must be finely powdered, preferably in an agate mortar. Particles greater in diameter than 1/5500 of an inch are inactive, and it may be said that as a rule, and other things being equal, the finer the particles the more distinct the movement, which is about 1/5000 of an inch at each bound. Of all substances, and the writer has tried hundreds, the metal uranium shows the movement most distinctly, and in a manner almost spectacular. Pure uranium should be used, and pounded in an agate mortar for 15 or 20 minutes, or at least until many of the particles are reduced in diameter from 1/10,000 to 1/20,000 of an inch. Put on a slide a quantity of the powdered material, equal in bulk to a mass 3 or 4 times the head of a pin, add a drop of distilled water with a trace of gum arabic, and observe with a 1/12 oil immersion objective. The whole field seems to quiver with life, and the finer particles dart from point to point with a motion strikingly analogous to that displayed by many micro-organisms.

When the film of the material is of proper thickness and the particles sufficiently reduced in diameter the phenomenon is beheld in a perfect *abandon* of color—the reds and blues being of metallic brilliancy.

The result will well repay one for the effort expended in reproducing this experiment, and, once seen, it can scarcely be forgotten.

The Utilization of Atmospheric Nitrogen

THE importance of nitrogenous compounds to the agricultural and industrial interests of Europe and America has prompted the Bureau of Manufactures to issue a monograph on the subject of utilizing atmospheric nitrogen in the production of such compounds. The nitrogen problem, one of the most pressing of the twentieth century, is unique from the fact that the material is unlimited. The atmospheric nitrogen above one square mile of land, amounting to about 22,000,000 tons, is equivalent to what the world would require in the next fifty years at the present rate of consumption. The problem is to utilize this nitrogen economically, and thus free the world from its dependence on the nitrate deposits of Chile, which are not particularly extensive and are likely to be exhausted at a comparatively early date. Remarkable results have been obtained in Norway by means of electric furnaces in which atmospheric nitrogen is oxidized to the form of nitric oxide, which is used in making calcium nitrate, or Norway saltpeter. This Norwegian product is already an important rival of Chile saltpeter, but as the success of the process depends upon a very cheap supply of electricity it will probably not be used to any great extent in the United States until the furnaces have been made more efficient. Cyanamide, another nitrogenous fertilizer of growing importance, is being manufactured in America and the industry should prove successful, as the production in this country of the calcium carbide required by the process is second only to that of Norway. The monograph describes in detail the results obtained by the leading European chemists in their efforts to increase the supply of nitrogenous compounds, and the commercial as well as the technical aspects of the new industry are dealt with at length. The author, Thomas H. Norton, consul at Chemnitz, Germany, on detail as commercial agent of the Department of Commerce and Labor, states in conclusion that the achievements of applied chemistry make it possible for American industry and agriculture to face with confidence the threatened exhaustion of the nitrate deposits of Chile.

Open-air Schools of Paris

IN the schools of Paris and other large cities the statistics show that there are on the average 15 per cent affected with tuberculosis, and although this may yet be in the latent state there is none the less a considerable danger for these persons for the future. Open-air schools are advocated for preventing the disease, and Messrs. Parmentier and Bernheim treated the question at the recent Tuberculosis Congress, stating that children so affected had the greatest benefit from their stay in such schools without suffering any drawback to their instruction. In the suburbs of Berlin a method of this kind is carried out in schools where the pupils are not lodged in the buildings. A type of boarding school is found in the suburbs of Paris, and the children are first examined so as to find out how long a time of stay will be of benefit to them. They are divided into groups according to their condition, and are also treated for defects in hearing or in the respiratory passages. The main treatment is a rational method in which open-air work and physical exercise play the most important part. Figures show that the results are excellent, and among the 800 pupils passing through the Vesinet school for the last two years, a great number starting from very bad health conditions received great benefit from even a few weeks stay in the open-air school.

Uses of Seaweed

SOME interesting facts about seaweeds which are used as food or for producing vegetable gelatines or glues, are brought out by Messrs. Perrot and Gatin in the annals of the French Oceanographic Institute. Seaweeds are not much used in Europe except for alkalies or iodine preparation. In the north coast regions of France the seaweed is used by the peasants as a manure upon the fields. Medical uses can be mentioned, and the variety called Iceland moss is collected in Brittany to a considerable extent, this reaching 20 tons of dry seaweed in 1904. One variety of seaweed is a very good vermifuge, and is extensively used for this purpose in Corsica. On account of the iodine which they contain, some seaweeds are remedies against goitre and scrofula. As to food uses, this seems to be limited to the Brittany region and only the poorer population consumes it. Although limited in Europe, the use of seaweeds as food is widespread in the extreme Orient. In Japan, edible seaweed is prepared in a number of ways and it is much cultivated. Iodine is not manufactured in that country at present. One use is for preparing agar-agar, gelose and vegetable glue. Seeing that the gelatines from this source are scarcely nutritious, the authors explain their extensive use by the manner of living, and as the populations consume great quantities of fish and rice it is thought that the gelatinous substances aid in digestion and in the intestinal functions. It is valuable for alimentation and export.

Wholesome Water in the Country

The Dangers of Pollution and How They May Be Avoided

By Frederick H. Billings, the Associate Professor of Bacteriology at the University of Kansas

[*PROF. FREDERICK H. BILLINGS is a man of considerable experience in matters relating to water supplies, this having been a part of his work in Kansas. He has been professor of botany and bacteriology in the University of Louisiana, 1901 to 1907, and associate professor of cryptogamic botany and bacteriology at the University of Kansas, 1907, and at the coming season is to be head of this department. He received the degree A.B. at Leland Stanford University, 1896; A.M., Harvard, 1897; and Ph.D., Munich, 1901. He has been bacteriologist to the Department of Water and Sewage of the Kansas State Board of Health. Much of his investigation and work have been along the lines of milk and butter. In addition to his regular studies Dr. Billings has taken two summer courses in bacteriology at the Harvard Medical School and one in dairying at the University of Wisconsin. At present he is at the Massachusetts Institute of Technology, where because of his high standing the courtesies of the laboratories and lectures are tendered to him. On his return to Kansas, besides his academic duties he will assume high responsibilities in the care of the State Analysis of Water.*—EDITOR.]

From very remote times, a good water supply has been considered one of the greatest blessings since the fight of Isaac's herdsmen for the wells of Gerar down to present-day irrigation. Its possession has been subject to contention. Possibly good water was of more frequent occurrence among patriarchal tribes in their nomadic life than in our modern settled habitations. At all events, the growth of civilization has pressed upon us the problem of combating the contamination of water supply.

How the Quality of Water is Judged.

The quality of water has generally been judged by its degree of sparkle, of turbidity, of temperature, and, since the introduction of soap, of hardness. These standards have their value, but they are considered by sanitarians to be superficial criteria for determining wholesomeness. Water may be hard, warm, flat and turbid and yet be safe to drink. It may also be soft, cold, clear and sparkling, and still carry infection. Wholesomeness depends upon comparative absence of salts and organic matter, deleterious to health. Injurious salts, while inducing disturbances of a more or less discomforting nature, even causing permanent injury if long-continued, do not create such serious consequences as polluting organic matter, especially if this takes the form of pathogenic micro-organisms.

It is believed that decaying animal refuse, draining from garbage heaps, barnyards, piggeries, manured fields, cesspools, privy-vaults, and the like, may occasion sickness when it finds its way into a water supply; but an equal degree of danger does not exist in all of these sources of filth. Animal manure and garbage are in a class by themselves in that they are not liable to contain the germs of disease that would produce infection in man through water. Cesspools and privy-vaults are in another class, since they are open to infection by bacteria particularly pathogenic for man. Water containing such germs assumes its most menacing aspect, especially if under the insidious guise of a cold and sparkling beverage.

It would be desirable, of course, if every source of water supply could be examined by a sanitary bacteriologist in order to determine the liability of contamination; but so huge is the task that the solution of the question in many instances must be left to the intelligent judgment of the resident himself. Bacteriological analysis, moreover, though the most reliable we have, may fail at times to tell the whole truth, especially if too infrequently made. Such analysis is concerned usually with the detection of the colon bacillus, an intestinal organism indicating fecal contamination, and condemning water by its presence, because of occasional association with infectious microbes of the same habitat. Of such, one kind is the well-known *Bacillus typhosus*, the source of typhoid fever, which, in this country, is the principal water-borne disease. Its germ is found in the intestines of typhoid patients, of convalescents, and for a while, of those who have fully recovered. It is believed, also, to occur sometimes in healthy people who have never been known to have had the fever. The excrement of all such individuals is laden with the specific organisms, and becomes exceedingly dangerous to others, if its disposal is improperly cared for. In rural districts, it usually finds lodgment in privy-vaults, cesspools, or on the ground, from any of which, permeations or washings containing living bacilli may find their way into some water supply. As the specific germ of typhoid is known to emanate only from infected persons, who constitute but a small percentage of the average community, the majority of country water supplies, even though otherwise contaminated, would be incapable of creating an outbreak of this particular disease. Typhoid, moreover, is not limited to water as a means of transmission, for contact and infected food play their part. But, after all has been said, it still remains true that water has often been a serious source of infection, causing numerous epidemics and disastrous loss of life.

The Water Supply of the Average Man.

The average man, when confronted with an adverse analysis of his water supply, is liable to be surprised, declaring that it is the best in the country, and that it has been used for years without producing illness. Granting that he be right, immunity in the past is no guaranty, unfortunately, for the present or future. In his case, some connection has evidently become established between well and outhouse or cesspool, and apparently he has not happened to harbor a typhoid-infected person on the premises. There is nothing needed now but the carrier of the specific organism to begin the trouble.

Rural water supply is generally obtained from springs, wells or cisterns. From a sanitary standpoint, springs and deep wells—deep in the sense of penetrating below the first impervious stratum—are the most reliable sources. The usual excellence of these, and, in fact, of all good ground water, is largely due to the filtering property of the soil. Springs, especially those flowing through fissures, and deep wells reap the benefit of prolonged filtration through earth. But both may be subject to contamination, particularly springs, which are often open to surface washings from sewage-drains, and the like, located farther up the slope. Hence it is advisable to inspect the watershed above a spring; also, to guard it from the surface washings by a wall or ditch.

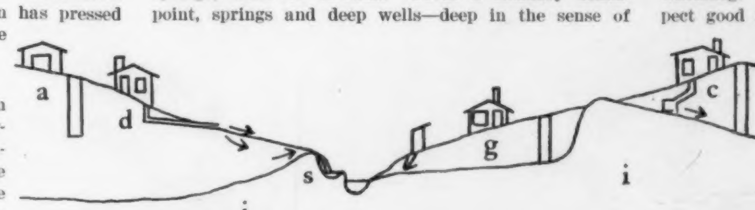


Diagram illustrating relations between water supply and sewage disposal in the country.

a, Stable with adjacent well, liable to contamination from surface washings and ground seepage. *d*, House with sewage drain to the surface. *s*, Spring in danger of contamination from drain just above. *g*, House with properly placed well and outhouse. *c*, House with cesspool, apparently properly placed on lower ground, but because of adjacent formation, the well is liable to contamination. The well at house *g* is in little danger from the cesspool because of the intervening impervious stratum of earth or rock (*i*, *i*), an impervious stratum whose relations to sanitation are important.

The Danger that Lurks in a Badly Located Well.

Driven wells and dug wells reach only to ground water, differing in this respect from many springs and all deep wells. Their shallowness brings them at times into proximity to drainage from privy-vaults, cesspools or leaky drains, and anyone sinking a well near these sources of filth must rely upon the filtering action of the soil to remove pathogenic bacteria. The filtering efficiency of the soil, in serving to protect wells from contamination, depends upon such factors as the extent and the nature of the intervening soil and also upon direction of ground-water drainage. The distance that should exist between a well and a source of pollution is, because of these, so variable, that probably no definite rule would be trustworthy in all localities other than the greater the distance the better. Nevertheless, from experiments conducted by the writer for the purpose, one hundred feet was found to be the least distance compatible with safety. A less distance would doubtless be safe in certain instances, but greater risk would be incurred of encountering or establishing direct connection through cracks or passages in the subsoil. Pumping a well, moreover, lowers the water table about it, causing drainage from adjacent soil toward itself as a center. Contaminating material within the radius of this flow would thereby be drawn toward the water supply.

The course of ground-water drainage toward its natural outlet affects the liability of a well to pollution. While it usually follows the direction of the superficial slope, it may take a different route, owing to peculiar subsoil formation. Therefore, while it is better to locate a well on higher ground than a cesspool or outhouse, it is also prudent to have a safe distance intervening as an additional precaution.

Driven and dug wells, though similar underground in point of possibility of contamination, differ materially when danger of surface pollution is considered. Driven wells are comparatively secure, while dug wells, open above, or covered with loose boards, through which filth may sift, or else with low and defective curbs, invite every sort of objectionable material that may fall or wash in. For this reason, dug wells are responsible for a greater extent of typhoid infection than any other source of rural water supply.

Cisterns, if underground and near leaky drains, cesspools, and the like, are exposed to conditions similar to wells, when they are not water-tight, and few of them are. In the South, where mild winters prevail, cisterns are usually above ground and are, therefore, not subject to soil pollution. Both kinds, however, are filled by roof washings, which, if not allowed to run to waste at the beginning of a storm, may carry refuse of an undesirable though not infectious kind. Cistern water has been known to be a vehicle for typhoid, but it is not so probable a source of danger in this respect as a dug well. Due care with regard to location, to entrance water, and to cleansing, should insure good water from a cistern.

Finally, it may be said that the maintenance of wholesome water supply of any kind requires constant watching. To dig a hole to water anywhere and expect good results forever afterward, is unreasonable. With the exercise of common sense, based on the knowledge of ordinary sanitary principles, a person should live in comparative security from water-borne disease.

Plants and Tobacco Smoke

PROF. MOLISCH, the plant physiologist of the University of Prague, has shown in some of his earlier work that large numbers of micro-organisms, plants as well as animals, and the seedlings of higher plants are extremely sensitive to the influence of tobacco smoke, some being even killed thereby. Many of the deleterious effects experienced by plants living in laboratories were formerly attributed to the small quantities of illuminating gas which frequently vitiates the atmosphere of such rooms; but Molisch's experiments left no room for doubt that it is really the tobacco smoke that does the harm. His pictures showing the growth of pea and vetch seedlings in the presence and in the absence of tobacco smoke are very striking.

In his more recent experiments he used older plants of various species, including species of spiderwort, *Echeveria*, *Eupatorium*, *Selaginella*, and others. None of these plants showed any ill effects from the treatment, although exposed for a long time to an atmosphere filled with tobacco smoke. Other plants, however, responded in various striking ways.

Brehmeria utilis and *Splitgerbera biloba* changed their manner of growth. When placed in a large bell jar and a few puffs of smoke from a cigar or cigarette were blown in, the leaves of these plants, ordinarily growing at right angles to the stem, that is, in a horizontal position, began to turn on their stalks, in the course of from 24 to 48 hours, until they were in a vertical plane. In the case of the *Brehmeria* they continued their rotations beyond this point, describing a spiral. Similar disturbances were produced upon these two plants by illuminating gas. But other plants used in the experiments showed similar effects of tobacco smoke, but did not respond to the illuminating gas.

Earlier experiments showed that various narcotics provoke abnormal development of the breathing holes on the shoot of the potato. Experiments with tobacco smoke on the potato and on other plants led to the same results, often with the accumulation of masses of liquid under the swollen areas.

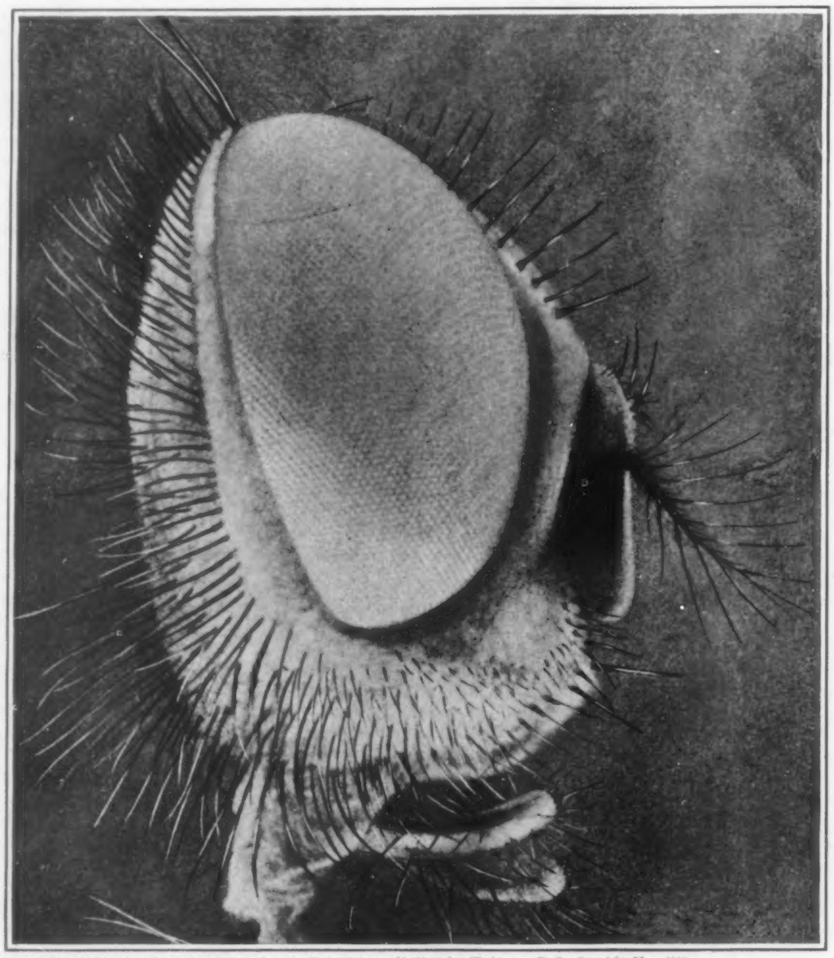
In some plants of the bean family the tobacco smoke caused the leaves to drop off in a very short time. The sensitive plant (*Mimosa pudica*) and the black locust (*Robinia pseudacacia*) and others lost all or nearly all of their leaves in from 24 to 48 hours after being placed in an atmosphere containing tobacco smoke. To a smaller degree smoke from wood and paper, and illuminating gas produced similar results. The fumes of nicotine had very little influence.

Insects and Disease

The Mechanical and Biological Methods of Transmission

By W. C. Rucker, M.S., M.D., Assistant Surgeon-Gene U. S. Public Health and Marine Hospital Service, Washington, D. C.

[MAN in the Stone Age was obliged to carry on an unceasing battle for existence with ferocious mammals and venomous serpents. Happily those days have passed, but to-day the struggle to live is no less acute, but it has resolved itself into a combat with the lower forms of vegetable and animal life. Insects as the intermediary vehicles in the transmission of disease are a menace to the present and future welfare of the race, and if we would preserve our physical integrity we must live in insect-free surroundings. The field for research into this problem is a wide one, and as yet has only been touched in its most apparent phases. The future must see a combined effort on the part of the entomologist, the physician and the sanitarian if we would conquer these dangerous and annoying pests. The burden cannot be borne entirely, however, by men of science; the citizen and man of affairs must do his part in the application of the discoveries which mean so much to the individual and the race.—EDITOR.]



Photograph by N. A. Cobb. By special permission from the *National Geographic Magazine*, Washington, D. C. Copyright, May, 1910.

This is a profile of a fly's head.

The large area studded with thousands of facets is one of the fly's compound eyes. A fly sees you not once but hundreds of times in all angular directions. That is why he so readily escapes your downward traveling hand. In addition to the facets he has three simple eyes at the top of his head in the middle, not visible in this picture.

The idea of the transmission of disease-producing organisms to man by insects is no new thing. For example, the Bible (Exodus 8 and 9) tells how the unusual prevalence of flies and lice was followed by a murrain of cattle and an epidemic of boils. It is only within recent years, however, that scientific workers have been able by the use of the microscope and other instruments of precision to trace the course of the seeds of disease through the body of the insect and into the body of man.

In order intelligently to approach the consideration of this latter day scientific development, it is necessary to understand the way in which the insect acquires the organisms which produce disease, the changes which these organisms undergo within the body of the insect, the way in which they are introduced into the human body, and the developmental changes which take place in them in the course of their attack upon the human victim.

Broadly speaking, there are two general methods by which this process is accomplished. These are the mechanical and biological methods. In the mechanical transmission of disease germs by insects, we find the insect in question coming accidentally in contact with disease-producing organisms and carrying them into the body of man either directly by biting, or indirectly as by infecting food. It is not necessary for the life of the germ in question that it be carried by any particular insect. No developmental changes, which are of any account, occur in the organisms during the period of this transportation to man, and therefore we may find many different insects of totally different habits acting as vectors for a given germ. As an example of the mechanical method of transmission, in contradistinction to the biological method of transmission, we have the carriage of typhoid bacilli from infected excrement by flies. In this instance the fly smears his feet, proboscis and wings with the discharges of a person who has typhoid fever, and then alighting on foodstuffs there deposits the germs to be taken by some unsuspecting person. In this instance no change whatever has been undergone by the bacilli, and they could quite as well have been carried by a cockroach which might similarly infect food. In the case of the transmission of tuberculosis by flies, the mechanical method of transmission still obtains, but it has been determined by experiments that, in this instance, there may be an actual multiplication of the tubercle bacilli within the body of the fly and that living bacilli may be discharged in the fly's excreta. In the case of the transmission of plague by the flea, another example of mechanical transmission, it is not necessary that any particular species o. ı act as the vehicle. The flea becomes infected by biting an animal which has the germs of plague in its blood. The flea imbibes this pest-laden material and subsequently bites a human being. It is not by the act of biting, however, that it transmits the germs of this d' ase. The flea has the habit of depositing his excrement at the time of biting. A person who is bitten naturally suffers some irritation and rubs or scratches the bitten place. Ir this the germs of the disease are rubbed into t which they penetrate and thus gain entrance to the body.

The transmission of malaria is a typical example of the biological transmission of a disease-producing parasite. The organism of malaria is a small unicellular animal which grows and develops in the red blood cells of man and in the various tissues of the *Anopheles* species of mosquito. This germ has two complete developmental cycles, one in the blood of man and the other in the body of the female *Anopheles*. The human cycle is the asexual cycle, development taking place without conjugation of the male and female elements. The mosquito cycle, on the contrary, is a sexual cycle, conjugation taking place. It is thus seen that for the perpetuation of this organism it is necessary that it alternate between the body of man and the body of the mosquito. Let it be supposed that a female *Anopheles* (males do not bite) bites a person in whose blood the *Hemamoebae malariae* exist. When this blood is taken into the stomach of the mosquito, the two different forms of the germ corresponding to the male and the female elements undergo a series of changes, and conjugation takes place. The result of this union penetrates the wall of the mosquito's stomach, on the exterior of which is produced a small cyst or blister. Development continues within this cyst, and many sharp spindle-shaped immature forms are taken up by the blood stream and carried to the salivary glands of the mosquito. When this mosquito bites another person it expectorates through the siphon which is used for extracting blood. It is said that the reason for act is a desire to thin the blood which is to be extracted. As the saliva is drawn from the gland in which the immature forms are lodged it is infected with them. These bodies thus introduced into the human system enter the red blood cells, and the person becomes infected with malaria. In yellow fever, although the appearance of the causative germ is not known, thanks to the preliminary work of Finlay and Carter and the conclusive experiments of Reed and his associates, the length of the developmental cycle in man and in the *Stegomyia* mosquito is definitely known.

Flies may carry the germs of typhoid fever, cholera, dysentery and tuberculosis, and it may be that these ubiquitous household pests may carry other diseases as well. Two varieties are commonly met with in this country, the *Musca domestica* or common house fly and the stable fly or *Stomoxys calcitrans*. Both are bred in manure, and it has been recently estimated that each pair of flies surviving the winter may be the ancestors of eight million living flies during the summer. Flies are omnivorous in their habits, and will eat filth of almost any kind. The first thing to do to get rid of flies is to exclude them from the home of man, and this may be accomplished by the use of screens, both as to doors and windows. These should fit accurately and should be constructed of some permanent noncorrosive material, such as bronze wire. Inasmuch as screens are also intended to exclude mosquitoes, the screening should have a mesh of at least eighteen to the inch. After this has been done, it remains to destroy the breeding places of the flies and get rid of those things which attract them. Stables or other out-buildings should be well screened. The manure should be stored in water-tight metal lined boxes which are emptied at least once in ten days. The frequent addition of chlorinated lime or soaking with kerosene oil will also prevent breeding. Stables should be maintained in a cleanly condition. The unsanitary garbage can is the fly's paradise. The water-tight metal garbage can with a tight-fitting lid will feed no flies. If the remainder of the premises is kept clean, few of these pests will be seen therein.

Mosquitoes of different species are known to transmit malaria, yellow fever, dengue ("break-bone fever") and filiariasis (the elephantiasis which is seen in the tropics). So far as is known, the mosquito type of transmission is biological. More than this, i. e., one general species only is concerned in the transmission of a certain disease. Since each of these species has its own particular habits, the methods to be used in destroying them should take into account these differences. In general, it may be said that mosquitoes do not travel far, and live and die on the premises on which they are bred. The yellow fever mosquito *Stegomyia calopus* is a small black and white insect breeding by preference in fresh, clean, quiet water. It is very generally distributed in a belt which extends around the world forty degrees on each side of the equator. In order that this mosquito may become infected, it is necessary that it bite a patient in the first three days of his illness. After having thus become infected, a period varying from eleven to twenty days (usually fourteen days, but depending upon the atmospheric temperature) must elapse before it may retransmit the disease. From that time to the end of its life, which is frequently as long as one hundred days, this mosquito may continue to distribute the disease among

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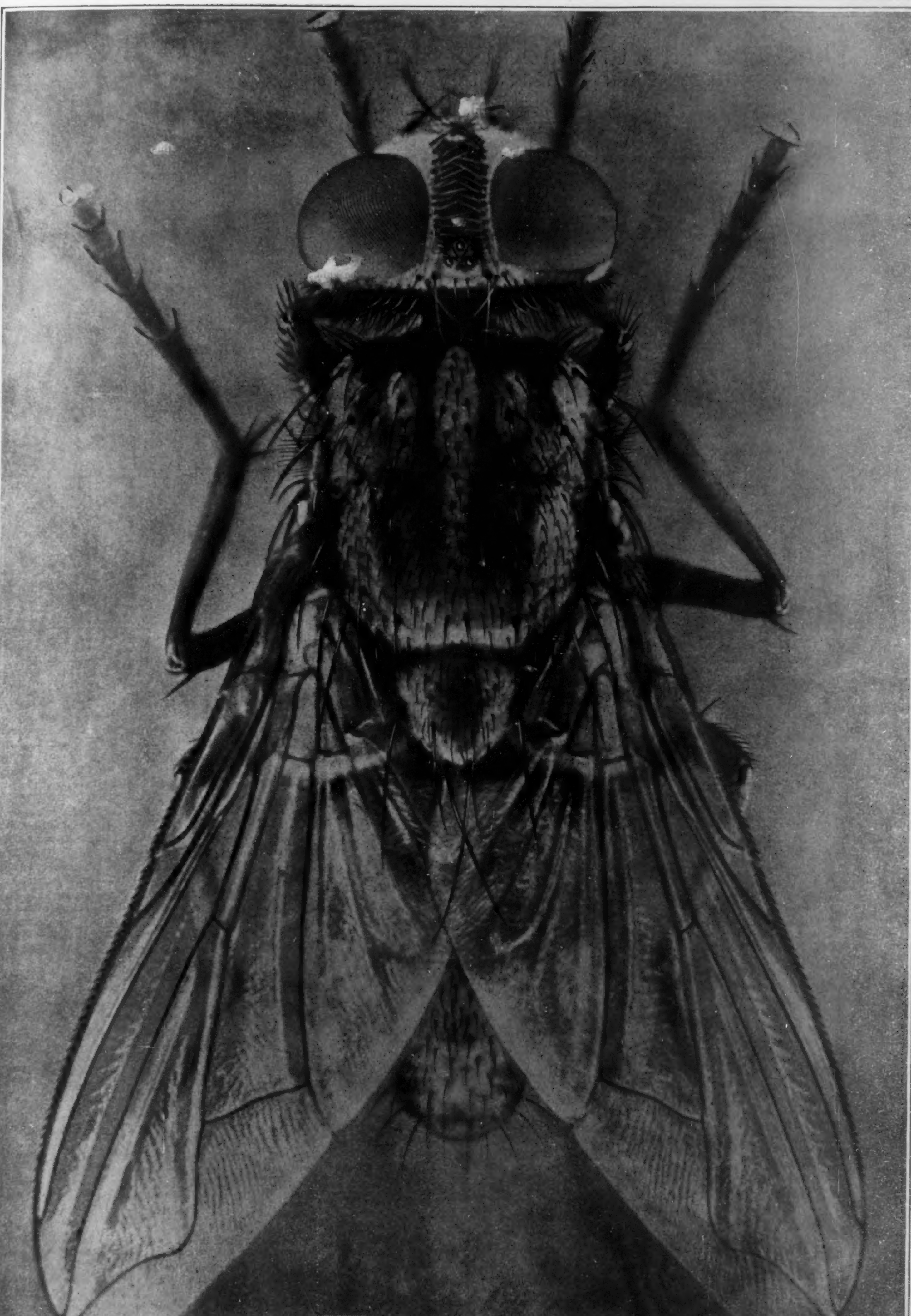

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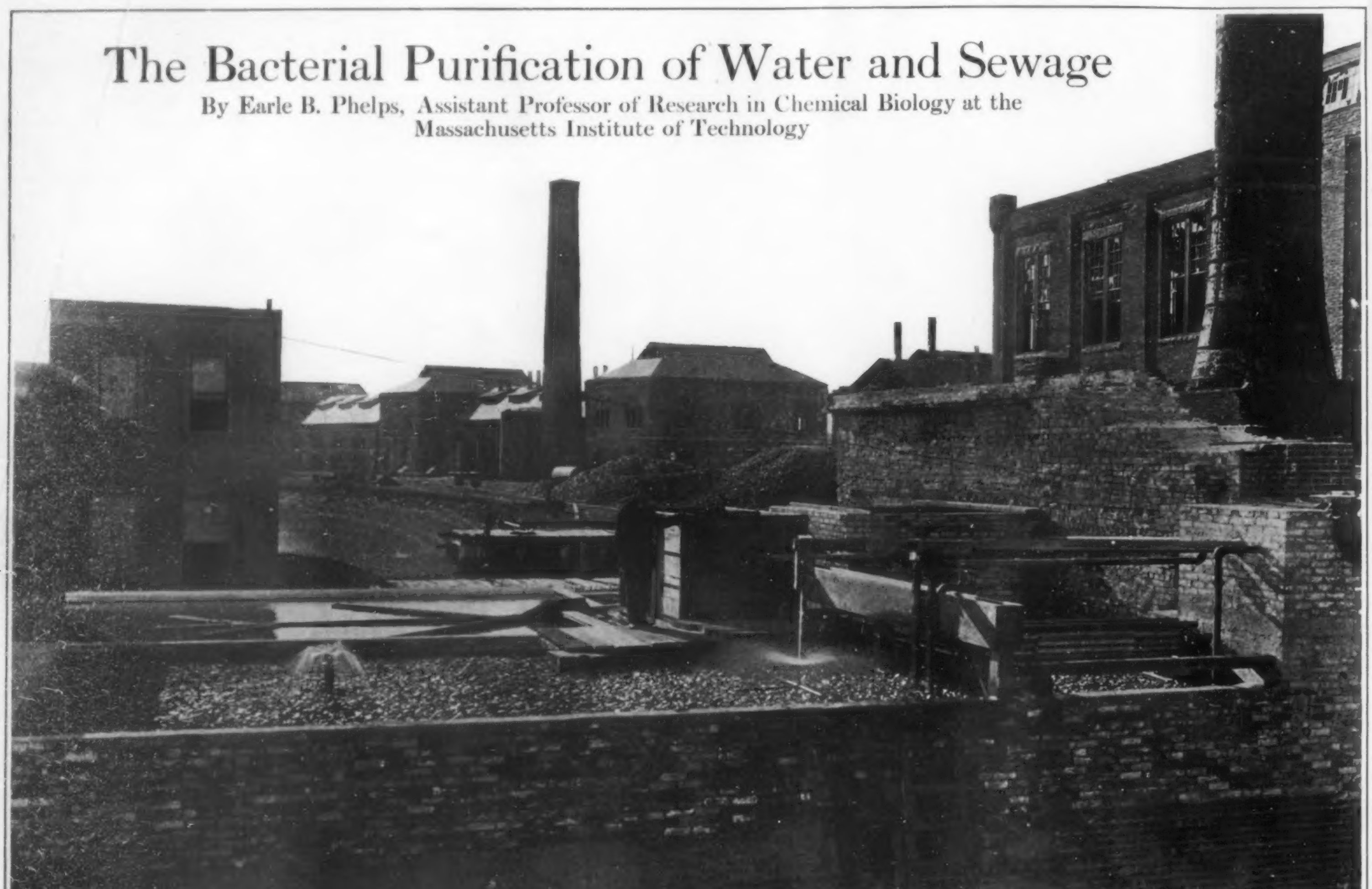
Your enemy the fly.

In addition to two claws, each of the six feet is supplied with two light-colored sticky pads. Germs and spores adhere to these pads and are thus carried from place to place with great rapidity; for the fly travels fast and far on its own wings, and on cars, boats and other moving vehicles. The fly cleans its feet carefully whenever they become contaminated, thus removing many of the germs that would otherwise be spread. Unfortunately the cleansing operation is not thorough enough.

The Bacterial Purification of Water and Sewage

By Earle B. Phelps, Assistant Professor of Research in Chemical Biology at the Massachusetts Institute of Technology



Filter beds of the Massachusetts Institute of Technology. Three kinds of distribution of sewage to the surface are shown—the small fountain to the left, the spray to the right, and still farther to the right, the fluted cylinder of the Fidian distributor.

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Water supply and sewage disposal are pre-eminently, although not exclusively, problems of modern community life. Upon the farm or country estate, and in the small villages, nature provides fairly satisfactory solutions of both. Springs or wells, on the one hand, and privies or cesspools, on the other, properly devised and maintained with regard to the elementary rules of health and cleanliness, constitute what may be called the natural solution. With increasing concentration of population the necessities of convenience and public health demand more extensive works. Here recourse is had to what may be called artificial methods, since they call for special scientific study and engineering construction. Nevertheless, as all science is but the orderly and detailed study of nature, so the modern science of water and sewage treatment is but an elaboration and intensive application of the natural processes. To the latter then we must look for the clearest and most basic exposition of the principles underlying the bacterial purification of water and sewage.

The soil has ever been the natural and final repository for the waste products of life. Even the gaseous exhalations of animals are captured finally by plant life and ultimately become part of the carbonaceous surface of the land. The soil has a tremendous and apparently inexhaustible capacity to receive and assimilate such wastes. It has been found that if soil be heated to a killing temperature this wonderful power is lost. In short, the soil, as we know it now, is not the lifeless substance we once thought it to be, but a veritable living world teeming with invisible things, bacteria, molds, and yeasts, as well as with larger animal life, worms and grubs. It is this living soil that devours all manner of waste substances, reducing them ultimately to the simpler mineral ash from which they came. "Dust thou art, to dust returnest" could be spoken of the body no more than of the soil were it not for these great, though tiny destroyers.

Let it be said now at the outset that this provision of nature is the starting point of all that follows. As the tea-kettle is to the steam turbine; as the kite and key of Franklin are to radio-telegraphy; so is the living soil to those two greatest achievements of sanitary science, the bacterial purification of water and sewage.

Nor is it wise to separate the two as is so often done. A good water supply is a prime necessity. Sewage disposal is the resulting prime duty. To bring a generous supply of water into a town without making due provision for its satisfactory removal is but a half-way measure that were in many cases better left undone. Such satisfactory removal must always involve the final disposal of the sewage in such a manner that no injury to the health, comfort, or property of the community in question or of any other one shall result.

With these few basic facts set forth, attention may now be directed to the methods by which natural forces have been directed and utilized in water and sewage purification. To further emphasize the importance of the disposal end of the system, and because it best illustrates the principles involved, let it be first discussed.

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The earliest successful effort to meet this responsibility was by "broad irrigation" or "sewage farming." As early as 1560 the sewage of Bunzlau, Prussia, was thus treated. This method consists simply in allowing the sewage to flow over large areas of cultivated land, where it is absorbed and utilized in a manner strictly analogous to the utilization of manure. At Berlin, the chief city now employing this method, over 43,000 acres of land are utilized.

The comparatively large areas of land necessary, coupled with certain objectionable features of the process, such as offensive odors and the possibility of disseminating disease by means of flies or through the crops, have caused irrigation to be viewed with less favor now than formerly. Even in those places where it is most extensively employed other methods of treatment are gradually being introduced.

From the broad irrigation field to the modern trickling filter progress has been along the line of more intensive action and consequently smaller areas. The Berlin fields provide an acre of land for every hundred people. In the next type of works to be developed the rate of treatment was increased ten-fold. This was the so-called intermittent slow sand filter which may be defined as a specially prepared irrigation field. It is distinguished from the latter in that it is either constructed upon sandy areas by the laying of underground drains, or else built up entirely of sand brought from some outside source. Crops are not as a rule raised upon sand filters, and higher rates of application of sewage are therefore possible. Sand filters of this kind can be made to purify sewage to a drinking water standard.

The use of the term filter is unfortunate. It is hard for anyone who has not especially investigated this matter to appreciate the real biological activity of such a sand bed. In the popular mind the action of straining is always most important, although in reality it amounts to little or nothing. There is, of course, a certain amount of material which will not pass into the sand, matches, paper, fiber, etc., and this has to be raked from the surface occasionally to allow free access of the air. The sewage itself, however, is absorbed and entirely purified within the sand bed, its outflow being a crystal, clear stream. The same natural process which takes place slowly in a manured field is carried out on a more intensive scale in a slow sand filter.

The results of this treatment are well nigh perfect, and no further investigations would be necessary were it not for the fact that in the neighborhood of large cities, land of suitable character and of sufficient extent is seldom available. Especially is this true in certain parts of the country where sand is uncommon. Efforts have been made to overcome both these difficulties by the construction of types of beds utilizing other materials than sand and capable of receiving sewage at much higher rates. The best known of these latter-day processes is the contact bed. This differs from the sand filter chiefly in the fact that crushed stone is employed for a filter medium. In this again we are dealing with biological oxidation of the sewage, an action due to the numerous minute organisms inhabiting the filter. Contact beds need breathing periods during which they

are filled with air, but with these included they are capable of treating sewage at a rate fully ten-fold that of the sand filter. Such a contact bed tends to accumulate material to a certain point, after which it reaches a condition of approximate equilibrium, dissolving and oxidizing the stored material at nearly the same rate at which that material is applied. Curiously enough, the accumulated material within such a bed when removed is found to be quite inoffensive in character and to resemble very closely a rich garden loam.

The latest and most important development in oxidizing filters is represented in the trickling filter. In construction this is similar to the contact bed except that it is deeper; as in the sand filter, the sewage passes continuously through the bed. The greater depth provides sufficient detention of the sewage and the better facilities for the extrance of air into the body of the filter make the oxidizing process more rapid. The trickling filter can treat sewage at rates two or three times those that are possible in the contact filter, so that as a result of 25 years' study the sewage of 25,000 inhabitants can now be disposed of upon one acre of land, whereas in the old irrigation fields one hundred persons was the safe maximum for the same area. This improvement in rate has not been secured without some sacrifice. It is not practicable to secure the perfect results of the sand filter in the rapid processes necessary for large communities. With the increasing rate there has been a decrease in the quality of the purification, especially as regards bacteria. The primary function of purification, oxidation of the organic matter, is performed satisfactorily, so that for the protection of streams and larger bodies of water these methods would suffice. But the effluents or outflows are not clear and attractive and the bacteria have not been satisfactorily removed. From a public health point of view, therefore, much is still desired in sewage purification. Fortunately, the investigator in sanitary science has been equal to the occasion, and means of chemical disinfection have recently been developed which effectively supplement the work of these most efficient oxidizing methods. But chemical disinfection is not strictly a bacterial purification and lies aside from the immediate purpose of this discussion.

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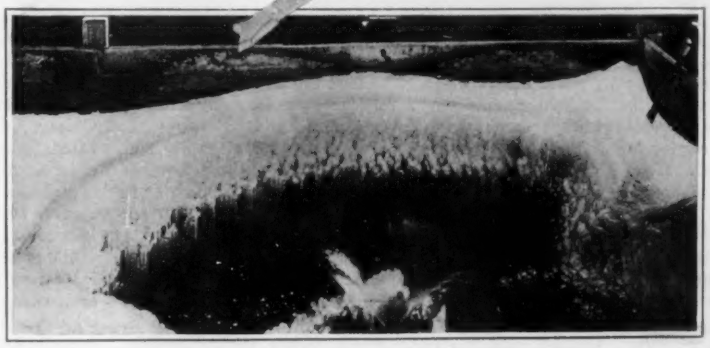
Water Purification.

Just as we have seen how the science of sewage purification employs those very principles by which the soil in nature brings about the ultimate destruction of organic matter, so in the field of water purification we again look to nature for our methods. Despite the obvious fact that the earth is the final repository of all things that have ever lived, both animal and vegetable, and that its surface is literally covered with organic material in the process of return to the mineral world, yet waters issuing from the ground have ever been regarded as the very emblem of purity. Closer investigation shows that this popular belief is well founded. No purer waters are to be found in nature than those which have passed through a considerable body of the earth, save in the single instance of newly fallen rain. One frequently finds pure crystal water issuing from a spring whose obvious source is some muddy, stagnant pool, filled with all manner of animal and vegetable matter, living or in various stages of decomposition. Between the two, therefore, there must be some ample purifying agency. This agency is found to be once more the living earth which has been so frequently referred to. If, now, these natural resources can be developed and intensified so that they may be utilized in artificial structures for the purification of water, the problem of a pure water supply will have been solved. This is exactly what has been accomplished.

Artificial beds of sand only a few feet in depth, carefully prepared with under-drains and properly operated to secure the maximum efficiency, constitute the sand filters upon which so much reliance is now placed in the purification of city w[illegible] supplies. Within these beds the bacteria find l[illegible]ent and increase enormously in numbers. The organic matter contained in the water, constituting its impurity, is seized upon by these small organisms and is transformed by them into harmless mineral residue. Rates of filtration are so rapid that in most cases there is also, incidentally, surface accumulation of debris composed of solid impurities in the water. This straining action is oftentimes regarded as an important factor in the work of these filters. To a certain extent this view is correct, but mere straining action would bring about little purification. The all-important item is the bacterial life within the bed of the filter. When this becomes incapacitated by low temperatures or by other unfavorable conditions, the efficiency of the filter diminishes at once. When conditions are most favorable for biological activity, efficiencies are at their highest. A simple calculation will show that the size of the sand grains is to that of the bacteria about as the size of an apple to that of a bird-shot, and illustrates how futile would be any attempt to strain out bacteria from a polluted water by mere passage through sand. How much more impossible would be the removal by straining of dissolved coloring matter, the dimensions of which are molecular. Yet both bacteria and coloring matter are removed in a well regulated sand filter.



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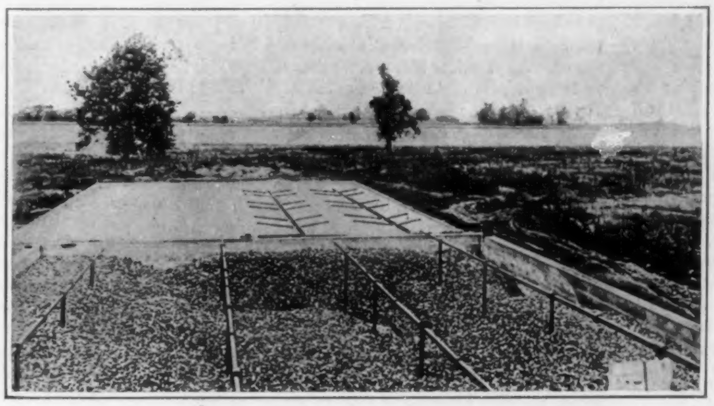

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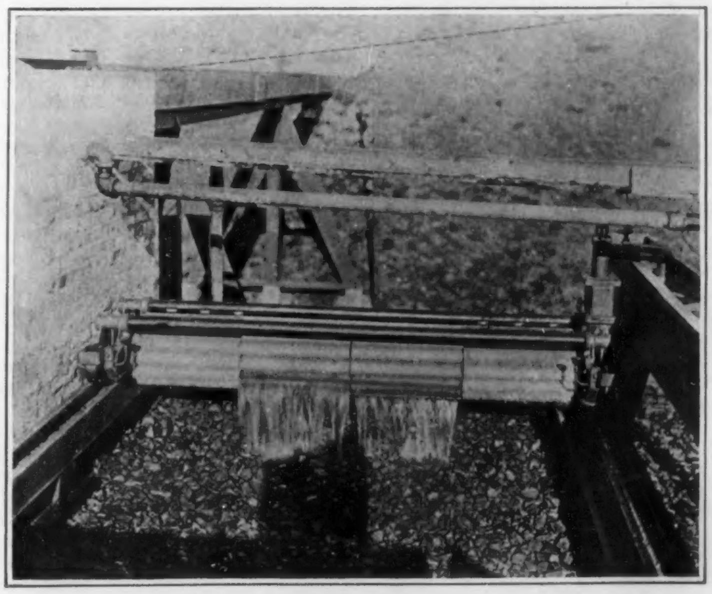

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The so-called "mechanical filter," developed largely in this country, is a very different mechanism. It operates at a rate about fifty times as great as the permissible sand filter rate and is purely mechanical in its action. For this purpose sand is also employed, although a coarser grade is preferred. Before passing through the sand, the water must first be treated with a suitable coagulant, alum being commonly employed. The alum enters into a mechanical combination with certain natural constituents in the water, gathering together all fine particles of suspended impurities and to a large extent absorbing dissolved impurities, such as color and odor producing substances. After the water has been coagulated in this way, it is allowed to settle, and is passed finally through these rapid coarse sand filters at a high rate. The filters strain out the remaining alum precipitate and the result is clear water quite free from bacteria and other impurities. This process is not truly bacterial purification, but it occupies an important position in American practice. The early objection to the use of alum in the water has practically disappeared. It has been learned that under proper management it is impossible for any alum or any resulting compound to pass the filter and reach the consumer.

These two types of water filtration have quite distinct, although at times overlapping fields of usefulness. The slow sand filter is especially adapted to the purification of sewage polluted waters where the removal of disease-producing bacteria is the object sought. In this field they seem to be distinctly superior to the mechanical filters. The latter are of especial value and even indispensable with waters that are highly colored or that carry clay or mud in suspension.

The most recent development in water purification, and one which has come into very general use within the past few years, is the so-called "hypochlorite treatment." This also is a purely chemical treatment and may be used either by itself or in conjunction with some filtration process. Its sole object is the destruction of disease-producing bacteria. Clear, colorless waters that are only slightly polluted lend themselves admirably to this treatment without filtration. Waters which have undesirable physical characters, color or muddiness are not improved thereby. As an adjunct to mechanical filtration, which, as has been stated, is not alone best able to deal with bacterial pollution, this process is most valuable. Its great economy and its simplicity of operation and excellent efficiency commend it highly. Its value is indicated by the fact that although it has been in use but a few years, it is now employed regularly by most of the large cities of the United States and Canada and by many hundreds of the smaller communities. There is a similar objection raised against this process to that which was raised in the case of alum, but this is bound to be short-lived. The time is fast disappearing when people are going to let weak, sentimental ideas of so-called purity stand in the way of real sanitary and economic progress. Man is frequently able to improve upon nature's work. Pure water is an ideal; but as between purified and unpurified water, even though the former involves the application of a disinfectant, the common sense of the community will not long hesitate. However we may reverence the ideal of purity, we will not take long to choose between disinfectants of well-proven harmlessness on the one hand and typhoid fever germs on the other.

The Problems of a Country Estate.

Thus far we have discussed water and sewage purification for large communities. It is here that the problems are most intense and that their successful solution means most for the welfare of the people.

(*Continued on page 45.*)

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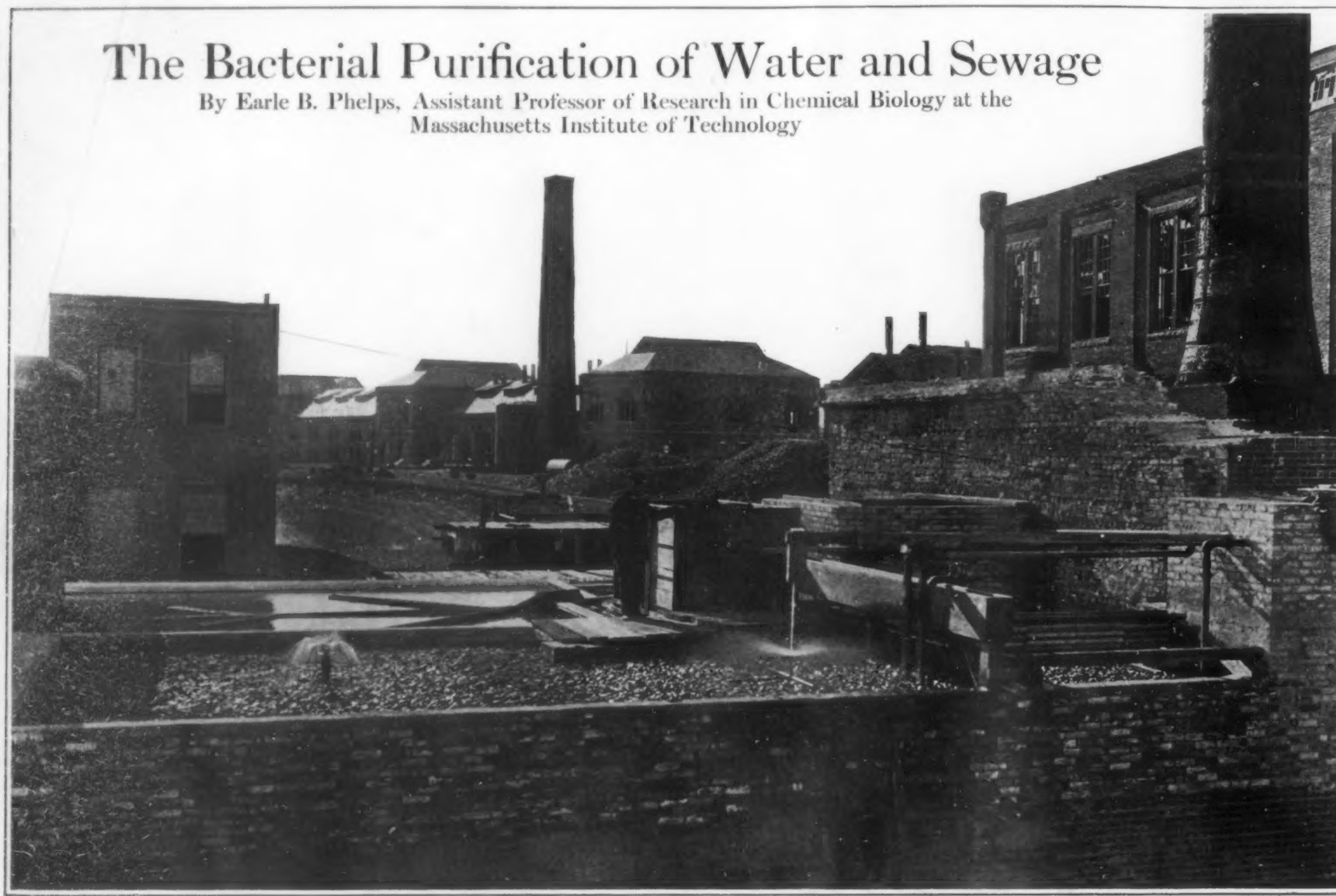

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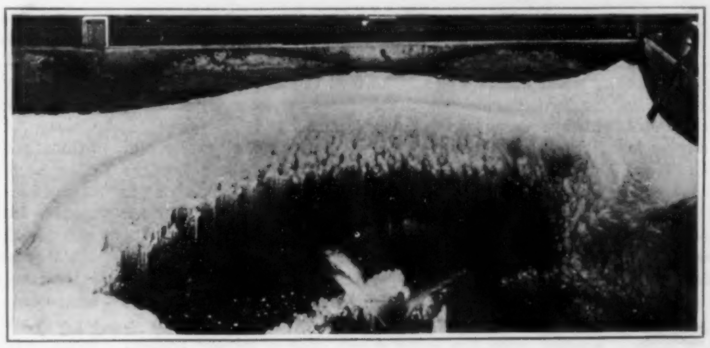

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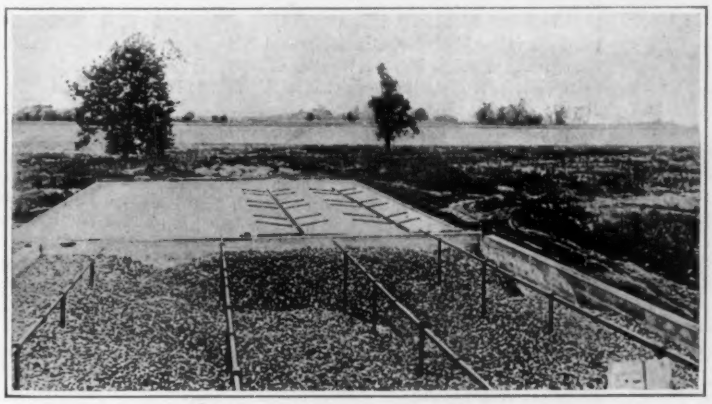

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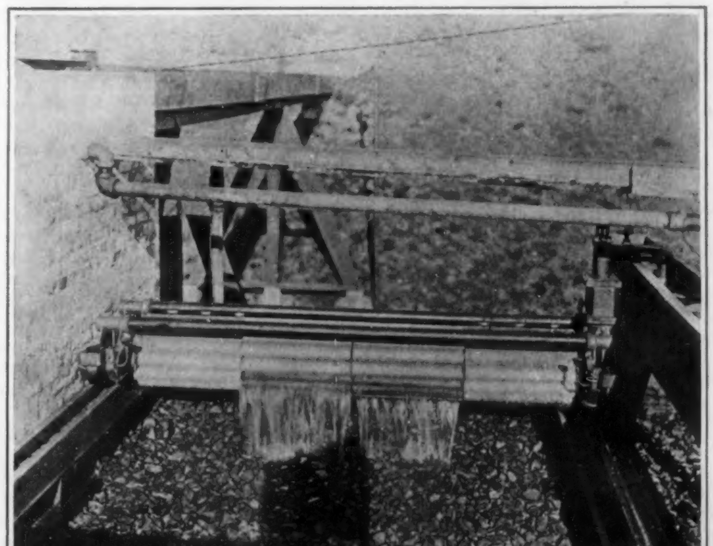

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The so-called "mechanical filter," developed largely in this country, is a very different mechanism. It operates at a rate about fifty times as great as the permissible sand filter rate and is purely mechanical in its action. For this purpose sand is also employed, although a coarser grade is preferred. Before passing through the sand, the water must first be treated with a suitable coagulant, alum being commonly employed. The alum enters into a mechanical combination with certain natural constituents in the water, gathering together all fine particles of suspended impurities and to a large extent absorbing dissolved impurities, such as color and odor producing substances. After the water has been coagulated in this way, it is allowed to settle, and is passed finally through these rapid coarse sand filters at a high rate. The filters strain out the remaining alum precipitate and the result is clear water quite free from bacteria and other impurities. This process is not truly bacterial purification, but it occupies an important position in American practice. The early objection to the use of alum in the water has practically disappeared. It has been learned that under proper management it is impossible for any alum or any resulting compound to pass the filter and reach the consumer.

These two types of water filtration have quite distinct, although at times overlapping fields of usefulness. The slow sand filter is especially adapted to the purification of sewage polluted waters where the removal of disease-producing bacteria is the object sought. In this field they seem to be distinctly superior to the mechanical filters. The latter are of especial value and even indispensable with waters that are highly colored or that carry clay or mud in suspension.

The most recent development in water purification, and one which has come into very general use within the past few years, is the so-called "hypochlorite treatment." This also is a purely chemical treatment and may be used either by itself or in conjunction with some filtration process. Its sole object is the destruction of disease-producing bacteria. Clear, colorless waters that are only slightly polluted lend themselves admirably to this treatment without filtration. Waters which have undesirable physical characters, color or muddiness are not improved thereby. As an adjunct to mechanical filtration, which, as has been stated, is not alone best able to deal with bacterial pollution, this process is most valuable. Its great economy and its simplicity of operation and excellent efficiency commend it highly. Its value is indicated by the fact that although it has been in use but a few years, it is now employed regularly by most of the large cities of the United States and Canada and by many hundreds of the smaller communities. There is a similar objection raised against this process to that which was raised in the case of alum, but this is bound to be short-lived. The time is fast disappearing when people are going to let weak, sentimental ideas of so-called purity stand in the way of real sanitary and economic progress. Man is frequently able to improve upon nature's work. Pure water is an ideal; but as between purified and unpurified water, even though the former involves the application of a disinfectant, the common sense of the community will not long hesitate. However we may reverence the ideal of purity, we will not take long to choose between disinfectants of well-proven harmlessness on the one hand and typhoid fever germs on the other.

The Problems of a Country Estate.

Thus far we have discussed water and sewage purification for large communities. It is here that the problems are most intense and that their successful solution means most for the welfare of the people.

(Continued on page 45.)

Sewage and the Farmer

A Problem in the Conservation of Waste

By W. T. Sedgwick, Sc.D., Professor of Biology and Public Health and Director of the Sanitary Research Laboratories and Sewage Equipment Station, Massachusetts Institute of Technology, Boston

[*PROF. WILLIAM T. SEDGWICK needs no introduction to those conversant with the story of public health education and its movements in the United States. Born at West Hartford, Conn., he graduated from the Sheffield Scientific School, Yale University, in 1877, with the degree, Ph.B., gaining Ph.D. at Johns Hopkins in 1881 and receiving Hon.Sc.D. from his alma mater in 1909. He was instructor of physiological chemistry at the Sheffield School in 1877 to 1879; fellow and assistant biologist at Johns Hopkins in the latter year, coming to the Massachusetts Institute of Technology in 1883. Here, from assistant professor, he has risen to Professor of Biology and Public Health and Director of the Sanitary Research Laboratory. He is the man who established at the Institute more than twenty-five years ago the courses in biology, later developed into public health work. So successful have they been that the graduates are directing large sanitary works in many parts of the country. Wherever there is an important question of pollution of water supply, or the discussion of conditions inducing infectious disease, he is certain to be consulted. He was one of the experts named by Pittsburgh to investigate the typhoid outbreaks in that city. He and his graduates, Winslow and Whipple, constitute the non-medical portion of the New York Typhoid Fever Commission.*

In an age when popular enthusiasm is seizing on fragments of scientific truth and magnifying them till they overshadow and obscure the fundamental and important facts, he has opposed the present craze for "swatting the fly," which at best is only warring on a symptom and neglecting the disease, or destroying the danger signal, while yet the danger exists. In these later years Prof. Sedgwick has stood sturdily for conservation. He is opposed to the wholesale destruction of foods because they are merely of inferior quality, and believes that Government supervision should preserve and make safe such products. This has brought him into disagreement with some of the Government methods. His present article is in the line of conservation of sewage, which is everywhere turned to waste, but which has in it valuable elements for some of the industrial or agricultural processes. —EDITOR.]

The farmer is always seeking for fertilizer for his fields and crops. It seems therefore at first sight as if the sewage of our towns and cities ought all to be carefully collected and turned back upon the farms that feed them. The farm feeds the city, why should not the city, plus air and sunlight, feed the farm? The idea is very old; yet it seems forever new. Chemistry confirms and enforces it; for nitrogen—that wonderful element, which, in its virgin state, seems so indifferent, so inactive, but in its compounds so full of energy and so much alive—nitrogen flows alike from sea and land, from fisheries and from farms into those living whirlpools which we call cities, there to revolve for a time and finally to be expelled, largely as sewage, in new chemical combinations, lower and less potent in the scale of energy, but still highly favorable as food stuffs for low plants and animals.

Some such reciprocation between city and country there actually is. The manure of city horse stables is carefully saved and sent back to the farm. Garbage is not infrequently likewise saved and sent back to piggeries in the suburbs. The carbonic acid gas given off by human beings, animals, plants and by the great fires and furnaces of cities mingles with the atmosphere and helps to maintain that mighty reservoir of carbonic acid upon which the green plants of sea and land draw for their raw materials for manufacturing starch and sugar and cellulose—three of the most important elements of human life and industry.

How We Waste Nitrogen.

But water and the nitrogenous wastes of cities are not often thus returned—at least not directly. More often they are emptied as sewage into rivers or harbors or the sea, to mingle there with larger bodies of water, which latter material returns to the farmer only after evaporation or distillation into the atmosphere and condensation as rain or snow or hail or fog or dew.

As for the nitrogen of the sewage, this comes back but slowly, if at all, and chiefly in fish, shellfish, seaweed, and other familiar products of the sea, so that there is nowadays a steady and a heavy drain of nitrogen away from the land and into rivers and the sea. The same thing is true of phosphate, and probably to a greater or less extent of the other elementary substances underlying plant and animal life. In short, there is to-day a constant sapping of certain indispensable elements of the food of plants and animals from the land to the sea, and only a limited return of these same elements from sea to land. To some extent this drain upon the resources of the land, and that means of the farmer, goes on even in an uninhabited region, for the ground waters which go to feed the streams, and which in dry times make up a very large part of many streams, always carry more or less nitrogen.

So, too, there escapes, even from a sewerless city, and from a region where the excreta of human beings are carefully collected and used in agriculture, through the ground water which comes from such regions, much nitrogen in the form of nitrates.

But undoubtedly the heaviest loss, the greatest drain, comes with the sewerage of cities and towns, and the quick discharge of solid streams of sewage directly into rivers or the sea without any previous contact with the earth which, like a mighty sponge, would hold the sewage for a time and give opportunity for chemical changes followed by absorption and assimilation by plant life. Under this, the modern, system the draining of nitrogen and phosphates away from the land is rapid and continuous; and it is no wonder that great scientists like Sir William Ramsay are giving to the subjects of "nitrogen exhaustion" and "nitrogen supply" anxious consideration.

The Farmers' Interest in the Sewage Question.

But if the sea is just now the gainer and a kind of nitrogen accumulator, ought not the fish to benefit and multiply exceedingly? And, on the other hand, if all sewage should be used in agriculture and our fishing continue or increase, would not the sea soon be depleted of nitrogen, and the fisheries disappear? This is an interesting question, but one which we need not try to answer here. What we are trying to do is to learn what is the farmer's interest in the sewage question, and that means: How can the farmer best secure the return to his lands of the nitrogen and phosphates which he sends to the city but which the city after using fails to return to him?

The easiest answer is that he should have the liquid wastes of the city at his disposal as he already has the atmospheric wastes and (sometimes) the garbage and the stable manure of cities. In other words, that the sewage streams of cities should be poured, not into rivers or the sea but upon the land, where their precious elements would not be lost or wasted but made over by plants into food for man and beast. This is the simple ideal solution of the sewage-conservation problem and of the prospective difficulties of the farmer.

The Effect on Fish of Withholding Sewage.

But it should be noted in passing, that this plan, perfectly carried out, would very likely seriously deplete or at least damage our fisheries, since fish life is rich in nitrogen and the amount of nitrogen in the sea, though immense, is not unlimited. Moreover, the theoretical way out is beset with many practical difficulties. The worst of these is the seasonal and climatic difficulty. Sewage is a constant, daily product of urban life, and must be disposed of daily and even hourly, rain or shine, in summer and winter, in wet weather as well as dry. But the needs of plant life are not thus constant or perennial, but highly variable, according to season, climate, temperature, rainfall and many other conditions. There is thus this difficulty: If sewage is to be disposed of satisfactorily to the community which has it to get rid of, it must be taken away by river, sea or farmer completely and uninterruptedly; by night and day, summer and winter, rain or shine.

This requirement is easily met by rivers or lakes or the sea, but not by the farmer, at least in regions of marked seasonal variation and considerable rainfall, for at times his crops, simply cannot and will not absorb any additional liquid, however nutritious. Hence the sewage at such times must flow off unpurified and liable to create a nuisance, while the crops suffer from excess of water. In the arid or the semi-arid regions the farmer may perhaps at all times and all seasons welcome the arrival of the sewage stream upon his land, for irrigation with sewage ought to be the best and most successful form of irrigation in such regions.

It is certainly a significant fact that very few, if any, successful sewage farms exist to-day in the eastern part of the United States. The subject of sewage disposal has now been agitated in America for about twenty years and during these years the problems of extended and improved agriculture have been studied as never before in this country by the U. S. Department of Agriculture and by the Agricultural Colleges and Experiment Stations of the several States; and yet it remains true that there is not one important example of extensive and successful sewage farming in the populous and urban Eastern United States. On the contrary, New York, Boston, Philadelphia, Baltimore, Washington, and many lesser seaboard cities pour their sewage into the sea, while Chicago, Cleveland, Milwaukee, St. Louis, St. Paul, Minneapolis, Cincinnati, Louisville, and many minor cities of the interior empty their sewage into rivers or lakes connected with the sea, so that the farmers nowhere recover from these cities the elements which they contribute to them.

The reason for this common practice is plain. It is easier and cheaper to secure quick, convenient and constant disposal of the huge volumes of sewage which our cities must get rid of, by the means actually adopted than by disposal upon land. And yet, if the sewage of Boston could be carried to Cape Cod, or that of New York to the sands of Long Island, Philadelphia's to the Pine Barrens of New Jersey, or that of Baltimore to the sometimes poor and thirsty soil of the Eastern Shore of Maryland, then might these comparatively desert places be made to blossom like the rose. But even so the fish of the sea would suffer, the gardens of the ocean being robbed to feed those of the land. Perhaps we have here only one phase of a world-old dilemma: the land rising solid from the sea only to be dissolved in rain and carried back to it in aqueous solution; the elements then picked out from the solution by plant and animal life, thoroughly deposited in shells or skeletons, and at death added together to make once more the solid earth.

It may be that if we do not use our sewage upon the land we shall by and by be driven to seek our food more and more within the sea. The Japanese and the Chinese eat not only fish but seaweeds, and it would be strange indeed if Americans likewise should give up the land vegetables of to-day for the sea weeds of to-morrow.

Objections to the Farm Use of Sewage.

From the sanitary point of view the utilization of sewage in farming is open to some serious objections. In the first place, the mere fact that sewage is brought to the farm at all, means that disease germs and parasites may come with it to places and persons previously free from access to a contact with these undesirables. In the second place, owing to the difficulty of escaping contact with it, farm hands, and through them their families, will be especially exposed to personal infection and in some cases to air pollution also. In the third place, certain products of the farm, and especially vegetables such as celery, radishes, turnips, beets and beet tops, spinach, water cress, lettuce, potatoes and onions; and certain berries or other things grown upon or near the earth, such as strawberries and peanuts, which are either eaten unwashed or "handled" preparatory to cooking; if they are irrigated with sewage or are grown on soils recently flooded with sewage, may become soiled with particles of excrement and infected with dangerous microbes or other parasites.

It must be confessed, however, that the experience of Berlin, the capital of the German empire, where the sewage of upward of two millions of people is disposed of upon sewage farms, seems to show that this danger is more theoretical than actual; for the death rate of Berlin from typhoid fever is one of the lowest among the great cities of the world, and the experience of Berlin in this respect is confirmed by that of many smaller cities in England and elsewhere. If it be asked why it is that Berlin, almost alone of all the greater cities of the world, has adopted sewage farming as its means of sewage disposal, the answer is that owing to its inland situation Berlin was compelled to devise some other means than sea disposal, and having only a small stream in its vicinity, was obliged to resort to some form of disposal upon land, i. e., either to intermittent filtration or to broad irrigation (sewage farming). The former is land disposal without reference to the giving of crops, the latter land disposal combined with agriculture or horticulture.

The conclusion of the whole matter is that, except in the more arid portions of the United States, the utilization of sewage in farming does not seem likely to increase at present. Consequently, we may have to look in the future for our supplies of food more to the sea and less to the land.

Curiosities of Science and Invention

READERS are invited to contribute to this department photographs of novel and curious objects, unique occurrences, and ingenious contrivances. Such as are available will be paid for promptly.

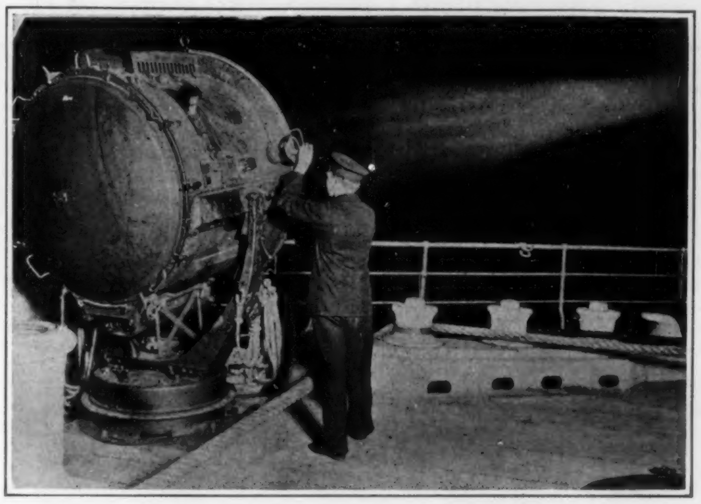
The Licensed Sand Sculptor

THE sand sculptor, familiar to visitors to the sea shore, has advanced from a small beginning and a somewhat checkered career to the dignity of a regularly recognized artist. At first the efforts of this picture maker were crude in the extreme. Fashioned from real sand the figures he produced were scarcely worthy of serious notice, either as art productions or as a bid for the coins of the beneficent. It was almost impossible to work with sand alone, and as the productions were as unsubstantial as the snow figures of the winter season, no one was interested in the "artist's" work to the extent of more than a glance in passing on the boardwalk at one of the seaside resorts.

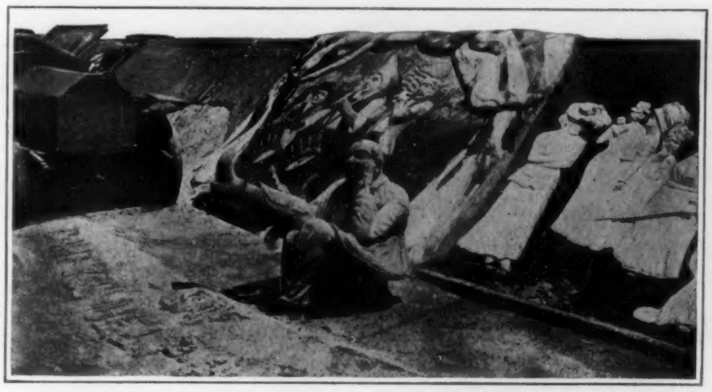
But in this country no one is satisfied for long with crudities. While sand artists abroad continued to work in sand alone, the American "sculptor" experimented with various materials until he had found something that would pass as sand but which was almost as substantial as hardened clay. As soon as the improvements began to be evident and the public began to take serious notice of the sand artist and his work it became a profitable business and the sands along the boardwalk began to swarm with "artists." Many were quite ignorant of art, but contrived to fashion a few figures that a good-natured public recognized as well intended, and rewarded with sn all coins. Some were genuine artists seeking in this way to pay for a summer vacation, or students trying to earn enough in the summer to weather the financial storms of the winter. These of course were annoyed by the ridicule brought on the business by the unskilled ones and encounters took place between rivals that at last compelled the authorities to take notice of the presence of the sand artist colony and take steps to regulate the business in some way.

Atlantic City was the first sea shore resort to insist on a license being first obtained before any one could stake out a claim on the sands and start business as a sand sculptor. There was appointed a committee to examine the work of the various artists and pass on its merits. The decree went forth that all work that could not pass muster with the committee as possessing some sort of art merit should be demolished and the artist driven from the beach. Some of the workers had been unwise enough to stoop to vulgarity in their creations and this hastened the work of the committee. The long line of sand sculpture exhibits that stretched along the front of the boardwalk was inspected closely and the committeemen retired to compare notes and report. Next day a band of large-footed policemen marched down the line and whenever they reached a sand sculptor's exhibit that had come under the ban they proceeded to stamp it to pieces, with a warning to the "artist" to come there no more. As a result of this proceeding the exhibits that will be seen this summer are only those that are really attractive and have some claim to being artistic.

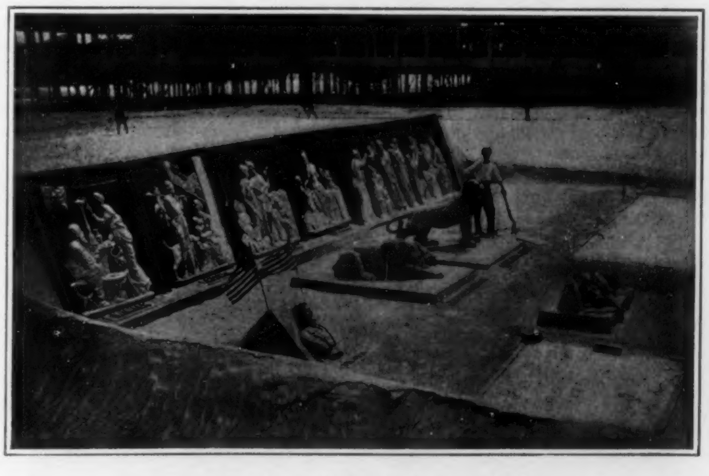
The figures are made of sand and cement mixed, to give the finished work the hardness of mortar. One of the best sand artists, the leader of the colony at Atlantic City, originated the exhibit of classic figures shown in one of the photographs. He was the first to construct his sand display on a slanting base so that the exhibit faced the board walk at an angle suitable for observation and he also gave the figures a coat of white paint which brought them out in bold relief against the dark sand. It was not long before others imitated the classic artist and even improved upon his idea. Subjects were selected that lent themselves to original coloring and with fine disregard for historical correctness the sculptors adorned George Washington, standing in the boat of sand in the act of crossing the Delaware, with a bright red coat and provided his sailors with blue shirts and his attendants with sartorial accessories of any hue that harmonized with the general color scheme.



An 80,000 candle power searchlight for a transatlantic liner.



A clever bit of work done in sand and cement.



General view of the classic figure exhibit.

"Empty" gasoline barrel exploded by the sun's heat.

First Searchlight for Transatlantic Liners

THE most powerful searchlight ever carried on a merchant ship was a conspicuous feature of the "Kaiserin Auguste Victoria," which arrived in New York recently. The great light, which is the largest type ever constructed, is designed for the steamship "Imperator." It is being carried across the Atlantic to be thoroughly tested at sea and on entering harbors. It throws a beam of light of 80,000 candle power. On approaching port, the searchlight was turned on the Scotland Lightship, rendering the name of the ship clearly visible at a distance of several miles. The great light is effective for seven miles at sea, and when thrown upon the clouds is clearly visible for a distance of thirty miles.

The searchlight reached the vessel only three hours before her sailing and was carried on the forward deck. It will be installed on the lookout, high up on the mainmast, where it can be swung quickly to any angle. The searchlight is of the type used heretofore only on the largest dreadnought battleships. The lens is 42 inches in diameter. It is operated by a current of 13,000 watts on a 110-volt circuit. In actual tests at sea, the ray has pierced fogs and distinguished distant objects at every point of the horizon.

Precautions With Empty Gasoline Barrels

THAT gasoline is dangerous is pretty generally understood, though the death toll from careless handling is heavy. Usually familiarity with any dangerous thing breeds contempt, but even down in the "oil country" gasoline is treated with a respect that is greater than that given to nitroglycerine.

Many persons have always had the wrong idea regarding the dangers from gasoline. They have taken the greatest precautions with the full barrels and have given scant attention to the partially filled and empty ones; in fact, very few dealers and users have ever given any thought to the care of empty gasoline barrels. That this is wrong is shown by the accompanying photo of an exploded "empty" gasoline barrel. This barrel "went up" while standing in the hot sun on the platform of the freight station. It is a 50-gallon barrel made of heavy iron. The heads are of a single sheet, slightly crowned and set on a projection rolled on the inside of the cylindrical barrel sheet. A solid welded ring is placed against and around the head and the end of the sheet is rolled over the ring and tightly crimped. In the exploded barrel the head was bulged like a grocer's scoop, the ring torn apart and the crimp of the barrel sheet pulled out straight. This explosion made a very loud report and the pieces were blown to a great distance. Fortunately, no one was injured, though some damage was done to other equipment about the barrel. By "empty" gasoline barrels is meant those that have been unloaded by dealers or garages, both public and private. They are the barrels rolled out to be returned to the refineries for refilling. These barrels are a source of danger and should receive greater care. The cause of the explosions of these barrels is the excessive pressure of the gasoline vapor generated when standing in the hot sun. A little oil is liable to be left in them and if the vent plugs are screwed in tightly there is danger of an explosion. Drain the barrels thoroughly and have the vents opened; also store the barrels in a cool or shady place.

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

Stagmatypy: A New Half-Tone Printing Process

IF a solution of gelatine is cautiously mixed with one of gum arabic the two do not coalesce into a single homogeneous solution, but form an emulsion composed of minute drops of gum suspended in the solution of gelatine. If a glass plate is coated with this emulsion an irregular vibratory movement of the gum globules, of the character of the Brownian molecular motion, may be detected with the naked eye, while observation with a microscope shows that the minute globules gradually agglomerate into larger, though still very small spheres, which finally come to rest at approximately equal distances from one another. The configuration can be fixed by carefully drying the plate.

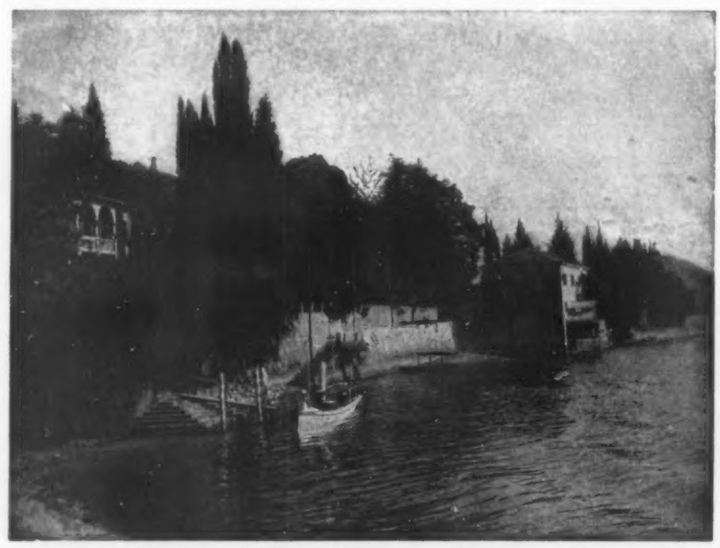
A plate of copper or zinc, coated in this manner with a gum-gelatine emulsion which has been made sensitive to light by the addition of potassium bichromate, forms the starting point in a new and remarkable half-tone printing process which Dr. Hans Strecker has devised, and named stagmatypy, from the Greek word *stagma*, a point.

In all methods of reproducing, by the printing press, photographs or other pictures having a continuous gradation of light and shade, the various tints, technically called "half tones," are represented by lines or dots separated by white spaces. All of these lines or dots are necessarily of the same color—that of the ink used in printing—but they vary in width according to the depth of tint, so that every gradation of the original picture, from black to white, is represented by the proportion of black lines or dots to white spaces in the corresponding part of the reproduction, as in a highly elaborated pen-and-ink drawing. This principle applies to all varieties of printing plates, including relief plates in which the raised portions alone take ink from the roller, as in wood-cut printing, etched plates in which the ink is wiped off the general surface but not from the depressions, and lithographic plates, which take the oily ink only at parts prepared for printing by previous applications of such ink.

The disintegration of the half-tones into separate lines or dots is usually accomplished by photographing the original picture through a fine grating of parallel lines or network of intersecting lines, photographed on glass. The result is a mechanical, lifeless print which often fails signally to reproduce the individuality of the original. The actual pattern of the grating, fortunately, is apt to escape the notice of the superficial observer, but it appears conspicuously under a magnifying lens and is often apparent to the naked eye. A person who has seen it in one picture is tempted to look for it and find it in others, and then his eye involuntarily follows the straight lines of dots, and the artistic effect is spoiled.

Several processes have been devised for making the "grain" of the picture less regular, but none of them have achieved complete and lasting success. In some of these processes the picture is photographed through a stippled or dotted screen, while in others no screen or grating is employed, but the "grain" of the half-tone print is produced by particles of asphalt applied to the metal printing plate in the form of dust, and then fused, before the sensitive film is applied. In the heliogravure process, for example, the polished copper plate is first dusted with asphalt in a special apparatus, and a second operation is required to melt the dust and attach it to the plate. A photographic copy of the picture is made on paper coated with bichromated gelatine and the undeveloped print is applied, face downward, to the asphalted copper plate. The paper is then washed off, and the gelatine film, which remains attached to the plate, is developed into a picture in relief by the action of hot water. This process, which is common to all half-tone printing methods, is based on the property of bichromated gelatine to swell in hot water to a degree inversely proportional to its exposure to light. After all of these operations the plate is etched by immersion in a bath of ferric chloride.

Even the ordinary half-tone process is tedious and laborious in comparison with stagmatypy, and the glass gratings employed are costly and fragile.



This half-tone was printed from a Stagmatype plate

The new stagmatype process is remarkably simple. The granulation required to reproduce the half-tones is effected automatically by the agglomeration and precipitation of the gum globules when the bichromated gum-gelatine emulsion is poured on the metal plate, forming a grain of approximately equal but not entirely regular pattern which, when dried, resists the action of the etching fluid very well. The plate is then exposed under an ordinary negative and immediately etched without having undergone the separate operation of development followed by drying and varnishing, which the ordinary half-tone processes require. The four distinct operations employed in heliogravure, namely, the formation of the grain, the coating of the plate with the sensitized or exposed film, development and etching, are replaced by two operations in stagmatypy. The grain is formed automatically during the coating of the plate, and development and etching are effected simultaneously by immersing the plate in a solution of ferric chloride, the water of which produces the development while the iron salt, diffusing through the film, etches the metal in exact correspondence with the progress of development.

This remarkable simplicity makes stagmatypy much cheaper, as well as more expeditious, than heliogravure or the ordinary grating method, both of which it may replace with advantage. The only conceivable additional amplification would be to make the original photograph directly on the printing plate, and even this may prove to be practicable.

Another example of Printing by Stagmatypy

Another advantage of stagmatypy over the ordinary half-tone process is the greater richness of detail obtained in the print. It is obvious that a photograph made through a grating or net cannot reproduce every point of the original. A continuous black line, for example, is necessarily represented by a broken line. In stagmatypy, on the contrary, the unaltered negative is laid directly on the printing plate, the grain of which is formed automatically according to the character of the picture, so that the reproduction of a black line is as continuous as the original. For the same reason, the stagmatype reproduction shows a great superiority in contrast and depth of shadows—qualities in which the ordinary half-tone print is sadly deficient.

In order to obtain fairly satisfactory results by the usual half-tone methods it is necessary to use very finely ruled screens and the best grade of printing paper, and to employ great care and skill in all of the operations. This is not commercially practicable for ordinary work, in which coarser screens are employed, with inferior results. In this respect, also, stagmatypy presents an advantage, for a coarseness of grain that would be intolerable in an ordinary process print is barely perceptible in a stagmatype print, where the grain is not arranged in straight lines and set figures. On the other hand, the automatic stagmatype process can be made to furnish a much finer grain than can be obtained from ruled screens. Stagmatypy, therefore, may be applied to all grades of paper and subject, from the finest art reproductions to newspaper illustrations.

The new process is particularly advantageous in color printing, because it cannot produce the *moiré* effect which is often caused by inaccurate adjustment of the regular patterns of the several colors in the ordinary process. In stagmatypy the colors are automatically blended, and their proportions can be regulated in a novel manner by varying the size of grain for the different tints.

The most important application of stagmatypy appears to be to lithography, both monochrome and polychrome. By printing the stone with a stagmatype plate etched in intaglio a wonderful softness of effects is produced, as only the fine interstices of the granulation are impressed on the stone. Another interesting application is to the direct reproduction of drawings in pencil, charcoal, crayon or India ink without the intervention of the camera. The drawing, executed on a sheet of gelatine or similar transparent material, is laid on the sensitized stagmatype plate in a photographic printing frame, and the plate, after exposure, is simultaneously developed and etched, in the manner described above. In lithographic copies made in this way the character of the medium, pencil, crayon, etc., is reproduced with wonderful fidelity.

For etching the stagmatype plates Dr. Strecker has devised an electrolytic method which greatly facilitates the operation. The plate, suspended in the ferric chloride solution, forms the anode. An amperemeter, included in the circuit, indicates the moment at which the action begins and the rapidity with which it progresses. Hence, the etcher is not compelled, as he is in the useful chemical method, to follow the progress of the action on the plate itself with the greatest care, in order to replace the strong etching bath by a weaker one at the right moment. He can, therefore, conduct the etching of a number of plates at the same time. The electrolytic etching process can be applied to zinc, brass or steel, as well as to copper.

Stagmatype plates retain their sensitive-

ness to light for a long time, copper plates for three months and zinc plates for more than two years. Hence they are likely to become articles of commerce, like ordinary dry plates.

The Trade-mark as a Business Asset

By W. E. Woodward—I

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[THE average business man has only the vaguest notion of the value of a trade-mark. He does not realize that it is very often the connecting link between the producer and the ultimate consumer; that it is a symbol of good will, a tangible asset with a determinable money value; that it must be chosen and applied not in a haphazard way but with a due regard for its psychological effect upon the public. Nor does he realize the importance of complying with the statutory requirements which secure to him a property right in a trade-mark comparable with the property right that an inventor acquires by taking out a patent.

The following is the first of a series of articles, written by a man who is at once a trade-mark, an advertising, and a business expert, a man who has a first hand knowledge of the value of trade-marks and of the correct methods of trade-mark exploitation. The series, which will be eventually published in book form, will include discussions, written in business English, of the Federal trade-mark law, analysis of the requirements for registration, the elements of a good trade-mark, and trade-mark protection.—EDITOR.]

If you should find in your Santa Claus stocking, next Christmas, a gift of the exclusive right to use the word "Royal" as a name for baking powder, you would be $8,000,000 richer than you were the day before. It is said, on good authority, that the Royal Baking Powder Company considers its trade-mark worth just $1,600,000 a letter. This is, perhaps, the most valuable trade-mark in existence, though it is rivaled in value by "Kodak," "Uneeda," "Ivory" (as applied to soap), "Coca-Cola," the name "Gillette," used in connection with safety razors, and a half-dozen others. Each of these trade-marks has become a national institution. To displace them in the public mind would require competition of unheard of magnitude and energy. The name "Coca-Cola" is worth at least $5,000,000; the Gorham silverware mark, $2,000,000, at a fair estimate; the trade-marks of the National Biscuit Company, all of which touch the highest standard of distinctiveness, must be the largest asset of that concern; and the name "Kodak"—where would the Eastman Company's business go to if it should hand over the trade-mark "Kodak" to some other concern, and go on making the same goods under the name of Smith's Hand Cameras? When the American Tobacco Company was recently dissolved into separate concerns, under the order of the Supreme Court, the trade-marks of the combination were estimated to have a value of $45,000,000, out of total assets of $227,000,000.

The aggregate total value of well-known American trade-marks must be in the hundreds of millions of dollars. But any estimate of the value of a trade-mark, apart from the business to which it applies, is necessarily a mere guess, for a trade-mark is a species of commercial property that cannot be sold by itself. It is inseparably attached to the business from which it emanates, and cannot be transferred without a transfer of the business. There are cases where a concern's trade-mark has become so valuable, through long years of popularity and profit-making, that it entirely overshadows all other assets of the business—in short, the business could not exist without it. A trade-mark is a symbol of good-will—using "good-will" in the same sense that the bookkeeper uses it. It stands for built-up reputation; it is the link that connects the ultimate consumer with the manufacturer. It preserves the identity of merchandise, and, in carrying out this function, it is a device of inestimable value to the commercial world.

Sometimes a complex chain of events is best explained by a simple illustration. With this idea in mind, let us put ourselves in the place of a woman who wants a cake of Ivory soap. She lives in a desert town in Arizona. She cannot go half across the continent to Cincinnati to buy a five-cent cake of soap from the makers. In fact, it is a safe bet that she never heard of the makers, but she knows that she wants Ivory soap. So she sends her little girl down to the "general" store, and this lisping messenger asks for "Ivory" soap—not just plain "soap"—and brings the familiar package with the name on it back to her mother. If the storekeeper sends some other kind of soap the owner of the nickel knows instantly that she did not get what she wanted.

By means of the trade-mark "Ivory" the manufacturers in Cincinnati deal with this buyer in Arizona as surely and as expeditiously as if she lived across the street from their factory. Trace this transaction backward, and you will find its trail running unerringly through the retailer, the wholesaler, and the jobber to the manufacturer—and at every stage of its journey the product kept its personality. It left Cincinnati as Ivory soap, and as Ivory soap it was put into the consumer's hands.

Selling by trade-mark is one of the miracles of modern merchandising. Its development to a state of high efficiency has taken place during the last hundred years.

The early decades of the nineteenth century witnessed the rise of three great forces which were destined to accomplish, in a short time, the most profound changes in manufacturing and selling methods. These forces were:

1. The application of steam power to manufacturing in a large and economical way.

2. The development of cheap and quick transportation.

3. The invention of means for the rapid dissemination of intelligence.

Factories employing thousands of hands—great industrial monuments to cheap power—had inevitably to find distant markets for their products. No longer could the manufacturer sit at home and await the buyer. His product was too large and its burden was too heavy to carry on a hap-hazard sales plan. Consequently, the selling departments of all enterprises grew tremendously in importance. Customers were sought across the breadth of a continent. Many a manufacturer's sales area grew, in the span of a generation, from a few hundred square miles to a region that included every degree of climate from the arctic to the torrid. To accomplish this result, efficient selling methods and economical and fast transportation were required. As a natural consequence of these conditions trade-marks grew in importance. Manufacturers without trade-marks found that they had no hold on their trade. The consuming public did not know them or their products by name, and they were at the mercy of the jobber, the wholesaler, and the retailer. They were supported by a chain of circumstances, of which every link was weak.

On the other hand, manufacturers whose trade-marks were firmly fixed in the public mind by reputation, began to see that they were, to a large degree, independent of the merchandising chain. The ultimate consumer knew their trade-marked products, and asked for them by name. Thus, by a process of natural evolution, the trade-mark developed in importance from a workman's tool mark to a symbol of good will—a business asset in a tangible form.

It is an axiom of legal philosophy that when a thing becomes valuable or desirable, legislation concerning its regulation and protection springs into being. Consequently one looks for, and finds, the beginning of specific legislation on the subject of trade-marks around the end of the first quarter of the nineteenth century.

Before the first trade-mark legislation, cases of infringement fell under the common law, and were decided in courts of equity.

H. D. Nims, a well-informed writer on trade-marks, says in his "Law of Trade-marks and Unfair Trade:"

It is rarely that one life sees the genesis and maturity of law, yet it has almost seen them of trade-mark law. In the eighteenth century there were a few scattered decisions which turned almost wholly on the question of fraud. With the rise and growth of machine-made merchandise in the earlier part of the last century, the matter of private marks of merchants to distinguish wares going out into the public markets of the world assumed importance and cases multiplied. Trade-mark law is one of the results of machinery. It is safe to say that the great mass of trade-mark and unfair-trade law is the development of the last forty years.

A structure, of which the foundation has been so recently laid, must necessarily be still unsettled. The rulings of both the Patent Office and the courts are, in many cases, contrary to precedent. In some instances, courts in different parts of the country have handed down contradictory decisions bearing on the same question. But, despite these drawbacks, a body of trade-mark law is being slowly formed, and it is only a question of time before our feet will be on firm ground.

Trade-mark cases should be entrusted to lawyers who have specialized in this branch of the law. The legal status of this subject is changing so swiftly that an ordinary lawyer, absorbed in general practice, cannot keep track of it.

A trade-mark has been defined as "any sign, mark, symbol, word or words which indicate the origin or ownership of an article as distinguished from its quality, and which others have not the equal right to employ for the same purpose. In its strictest sense, it is applicable only to a vendible article of merchandise to which it is affixed." (Ball v. Broadway Bazaar, Court of Appeals, N. Y., 87 N. E. 674.)

We give this definition because it expresses in the fewest possible number of words the function and limitations of trade-marks. Also, because there is in the minds of many business men, a confused notion of the difference between a trade-mark and a trade-name. By referring to the definition it will be noted that a trade-mark is "applicable *only to a vendible article of merchandise to which it is affixed.*"

On the other hand, a trade-name applies to a business as a whole, although this business may be engaged in the sale of not one vendible article only, but a thousand. For instance, "Wanamaker's" is a trade-name and "Kodak" is a trade-mark.

A trade-mark has no value except that created by the quality, sale, popularity and profit in the article to which it is affixed. No matter how distinctive or attractive a mark may be, it is worth but little if it is used in connection with an inferior article or with an article sold without profit.

But a distinctive and suggestive trade-mark is of immense help in advertising and selling. Consider, for example, the trade-mark of Old Dutch Cleanser. It is full of *human interest, motion, life,* and *suggestion.* It brings up in the mind the mental picture of dirt fleeing from an energetic Dutch scouring woman. That this mark has been a powerful aid to sales is obvious. Suppose Old Dutch Cleanser had been called Climax Cleaning Powder? Can you imagine anybody getting together anything more than the most languid interest in anything with a name so dull? It reminds one of hard and sordid toil.

Notes for Inventors

Wanted: A Domestic Dough Kneader.—Boys down South can remember how their mothers made beat biscuits, known as "Maryland Biscuits." By means of a fluted roller of hard wood journaled in upwardly projecting cleats at the sides of a bread board, the material was mixed. The roller had a hand crank. The board was large and clumsy and it was quite a job to hold the board and turn the roller in the stiff dough. Why does not some inventor devise a small compact dough worker adapted for domestic use, having means for securing it rigidly to a suitable support and so geared as to render its hand operation easy for a woman or child?

To Protect the Aviator.—Francois Rillean of Los Angeles, Cal., in patent No. 1,027,346, provided an inflated double-walled body in the form of a frame having an opening or cavity to receive the aviator, a double-walled roof forming a head protector and the floor of the cavity forming a seat for the aviator.

Opening a Sash Lock from Outside.—If you have ever forgotten your door key and found all windows locked, you will appreciate the importance of this suggestion: Some one should devise a sash lock which can be opened from outside by any person party to the secret. There might be some form of combination or some secretly disposed tripping device, by which the lock could be released whenever the necessity arose. If the improvement lock should be slightly more expensive than the commercial lock, it would only be necessary to apply it to one sash, that on the window most convenient to enter, and it would often be found useful when the door key had been left in the house.

A Trough-shaped Aeroplane.—Joseph A. Williams of Cleveland, O., has patented, No. 1,027,954, an airship in which the plane is in the shape of an open-topped wedge-shaped trough which increases in depth and width from its front toward its rear end, is open at its ends and has a suitably driven propeller at the rear wide end of the trough.

Made Money by Invention.—An attorney tells of a client who went to Washington a little over a year ago to secure a patent. Recently when in Washington, he told of having made sixty-five thousand dollars the past year by the manufacture and sale of the invention. He produced an article that went into almost general use in a very active, prosperous industry and his problem became simply one of supplying a persistent demand. To find an active industry and supply a revolutionary improvement is a royal road to fortune.

Death of Major Janney.—Major Eli H. Janney, the well-known inventor of the automatic car coupler, recently died at his home in Alexandria, Va. The Major was a native of Loudon County, Va., and entering the Confederate army became a staff officer of Gen. Robert E. Lee. Shortly after the war, while engaged in business in Alexandria, he conceived the idea of the automatic coupler which for so long bore his name, "Janney coupler," and was a representative of the type which has come to be known as the M. C. B. or "Master Car Builders" coupler. He soon demonstrated the practicable character of the invention by its actual use on a Virginia railroad, and the importance of his invention is acknowledged throughout the entire railroad world. Although more than eighty years old at the time of his death, he is said to have been engaged up to about two years ago, when stricken with his last illness, in experimenting with improvements upon his original invention.

Safety Appliance for Airships.—Louis W. Stolp of Washington, D. C., has secured a patent, No. 1,029,475, for a safety appliance in which there is a movable element which holds the operator's seat in place upon the framework of the machine. A parachute is connected with the operator's seat and has automatic means to open its umbrella portion. Means are provided for releasing the operator's seat by hand from its connection with the framework of the machine and means are also provided which automatically release the opening means for the umbrella portion when the seat is released. By this construction, in case of accident, the operator can release the seat from the machine and will at the same time release the umbrella portion of the parachute, so it may operate to control his descent.

INQUIRY COLUMN

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry may be repeated. MUNN & CO., Inc.

Inquiry No. 9240.—Wanted, addresses of owners of limestone beds running not less than 98 per cent, and near a railway.

Inquiry No. 9241.—Wanted, addresses of owners of deposits of molders' sand suitable for heavy castings

Inquiry No. 9242.—Wanted, addresses of makers of keg valves.

Inquiry No. 9243.—Wanted, address of maker of Rover's monogram embossers.

Inquiry No. 9244.—Wanted, address of manufacturers making rollers, scrapers, and driers suitable for making soap leaves.

Inquiry No. 9246.—Wanted, addresses of parties having raw materials or minerals containing potash in any form.

Inquiry No. 9247.—Wanted, to buy a Parmelee aerated water.

Inquiry No. 9254.—Wanted, the name and address of manufacturers of lead pencils and pen holders, such as are used for printing advertisements on.

Inquiry No. 9255.—Wanted, to buy a patent roller, a ball-bearing axle, which could be purchased on a royalty basis; it must be cheap and fully proved.

Inquiry No. 9256. Wanted addresses of parties having Pitchblende deposits, if able to ship ore.

Inquiry No. 9257. Wanted addresses of firms selling second-hand water turbines.

Inquiry No. 9258.—Wanted addresses of parties having gem materials to offer in any part of the world.

Inquiry No. 9259.—Wanted to buy a machine for removing the coating of a filbert.

Inquiry No. 9260.—Want addresses of parties able to ship corundum, garnet, flint, emery or any material suitable as an abrasive.

Inquiry No. 9261.—Wanted, a manufacturer to make card games.

Inquiry No. 9262.—Wanted, to buy a glass which is a conductor of electricity and the address of the makers of the same.

Inquiry No. 9263.—Wanted, name and address of manufacturer of pantaloon stretchers with clamps which is capable of being folded up.

Inquiry No. 9264.—Wanted, the name and address of manufacturers of Date Pitting Machines.

Inquiry No. 9265.—Wanted, names and addresses of manufacturers of machinery for making picket fences.

Inquiry No. 9266.—Wanted, to buy machinery for fastening wire cloth to wooden frames with coppered tacks.

Inquiry No. 9267.—Wanted addresses of manufacturers of metal specialties in connection with plate or window glass.

Inquiry No. 9273.—Wanted, to buy a globe for a parlor fountain, working on the Heron system.

Inquiry No. 9274.—Wanted, the name of a manufacturer of a machine to make cushion covers for fruit crates.

Inquiry No. 9275.—Wanted, name and address of manufacturer of stock patterns of platen job printing presses.

Inquiry No. 9276. Wanted a household convenience and necessity which can be retailed at a profit at a price of from $1.00 to $2.00.

Inquiry No. 9277. Wanted. A machine for packing dry batteries.

Inquiry No. 9278. Wanted. A machine for separating crab meat from the shell.

Inquiry No. 9279. Wanted. A machine for shredding asbestos board.

Inquiry No. 9281.—Wanted to buy machinery for bleaching walnuts and ivory nuts.

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel.

BELT.—T. HERSHKOWITZ, 944 Union Ave., Bronx, N. Y. This invention provides a resilient belt for trousers mounted upon the waistband thereof to maintain an approximately constant pressure on the person of the wearer while expanding to accommodate the movement of the person; provides resilient means for said belt to increase the period of service of the belt; and provides guide members for the belt, said members being attached to the trousers.

Pertaining to Aviation.

AEROPLANE.—D. R. DAVIS, Franklin and Willard Sts., Hollywood, Los Angeles, Cal. This invention is applicable to various types of aeroplanes, but particularly applicable to that type in which the balancing is effected by a relative movement of the parts of the main supporting plane. Automatic means provide to keep the main body in its proper position when cross or vertically-directed currents of air are encountered.

Electrical Devices.

TELEGRAPHING INSTRUMENT.—C. C. FERGUSON, 841 St. Nicholas Ave., Manhattan, N. Y. This invention produces an instrument attachable to a typewriting machine for use in conjunction therewith whereby the telegraphing instrument is operated in harmony with the typewriting machine; produces an instrument which may be adapted as an attachment to typewriting machines of usual construction; and provides an attachment wherein the telegraphing circuit is closed when the use of the instrument is discontinued.

Of Interest to Farmers.

PLANTER.—R. ALLEN, Mason, Okla. Mr. Allen's invention provides a planter which will plant the seed at varying depths and thereby secure a better stand. As with this planter some of the seed are planted near the surface, while other seed planted nearby are planted an inch deep, the farmer using this planter will be certain in all cases of obtaining a good stand no matter what the weather conditions may happen to be.

GANG AND MOTOR PLOW.—E. B. SELLARD, 618 Franklin Ave., Mexico, Mo. The object of the invention is to effect an improvement in means for attaching, suspending, and adjusting plows with reference to a frame supported upon wheels which is supported on wheels. When an obstruction is met, the plows and frame rise until it is passed, when they resume their proper position.

GEARING FOR MOTOR-DRIVEN PLOWS.—E. B. SELLARD, 618 Franklin Ave., Mexico, Mo. In order to provide for driving a plow at high or low speed and steering the plow by power as well as by hand, Mr. Sellard connects the motor by sprocket gearing to the countershaft, which in turn drives a supplementary shaft, a double clutch being employed that will throw either a step-down or a step-up gearing into action. The traction wheels are driven by the supplemental shaft through a pair of clutches, either one of which may be disengaged to release the wheel it controls, and thus permit of steering the plow by motor power.

Of General Interest.

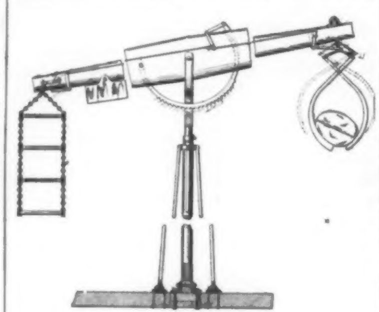
PORTABLE DERRICK.—M. G. BEAN, Walcott, N. D. This derrick is capable of being carried around by hand or on wagons and handled preferably by one person. It comprises a pair of posts swiveled relatively to each other and adapted to be folded to different angles relatively to each other for different purposes and embodies a number of structural improvements whereby its efficiency as a derrick and its compactness and adaptability are greatly increased.

CREDIT ACCOUNTING APPLIANCE.—A. L. LAMBERT, Concordia, Kan. The intention in this case is to provide an appliance more especially designed for the use of merchants, to keep the accounts of customers who buy on credit in a very simple and accurate manner, to allow a salesman to readily ascertain the customer's account, and to permit such salesman to make additions to the customer's account.

BOX.—W. S. ADLER, care of Empire Plow Co., Cleveland, Ohio. One purpose of this invention is to provide a box having a plurality of shelves movable relative to one another so as to expose simultaneously the contents of all the shelves, which can be folded up in a convenient, air-tight manner, so that the contents will be protected from dust and dirt and kept perfectly fresh.

MOLD.—H. W. STRIETELMEIER, Route No 3, Linton, Ind. The object here is to provide a mold more especially designed for making concrete fence posts and like articles, and arranged to allow convenient and secure removal of the post after being molded to permit immediate re-using of the mold for forming another post while the first one is setting.

HOISTING APPARATUS.—F. M. DAUGHERTY, Byron, Wash. This invention relates to hoisting apparatus for handling bags or bales, or other merchandise, and has reference more particularly to apparatus of this class which comprises a beam, means associated therewith for holding a load, means for gravitationally operating the beam to raise the load, and automatic means controlled by the load-holding means for locking the beam against movement in one direction. Besides



HOISTING APPARATUS.

being useful in warehouses, it can advantageously be used in lifting and transferring weights from point to point. The engraving shows a side elevation of an embodiment of the invention, having parts in cross section and parts broken away.

DRYING TABLE.—F. I. BURGHER, care of Acme Cloth Shrinking Machinery Co., 11 E. 4th St., New York. The cloth in the piece is passed over the table to dry before shrinking it, the table being arranged to insure uniform drying of the fabric with the greatest economy of steam used as the heating medium, the table being made in sections capable of being readily set up, or taken apart for packing in a small space, for shipping, storing, etc.

Heating and Lighting.

INCANDESCING ELEMENT.—D. J. MONOSMITH, Spencer, Ohio. This inventor has produced an incandescing element made up of laminæ or plates, each plate being weakened by aid of score lines so as to cause the plate to break along said lines if it breaks at all, thereby preventing fracture of the element along any line or plane except one parallel with said score lines or with plates.

Household Utilities.

TEA BREWING APPARATUS.—C. A. SHERMAN, 381 4th Ave., Manhattan, N. Y. This invention provides an urn composed of two independent units, in the upper one of which the tea or other infusion may be brewed and directly withdrawn from the same; or the infused liquid may be withdrawn from its contact with the tea or other substance from the lower unit or receptacle.

Machines and Mechanical Devices.

MATCH MAKING MACHINE.—S. E. RAHE, 918 Madison St., Brooklyn, N. Y. This invention relates to match making machines having an endless chain of carrier plates for securing the splints and carrying the same from device to device for automatically completing the matches and finally ejecting the same.

Pertaining to Vehicles.

DRIVING GEAR FOR MOTOR VEHICLES.—O. J. GRAN, Callahan, Cal. This improvement provides a driving gear for automobiles and other motor vehicles, arranged to transmit the power applied by the motor to the rear axle to the front axle without interfering with the steering gear, to compensate for the variation of speed of the front or steering wheels when turning from a straight path, and to prevent skidding.

AUTOMOBILE.—W. E. STANLEY, care of Bank of Bay Biscayne, Miami, Fla. In this vehicle the frame carrying the motor may be raised considerably above the ground and be supported in this position, so that the plow shares or shovel members may be carried between the wheels and below the frame, to work the soil as the automobile is driven by its motor. The machine may readily be converted from a pleasure vehicle to one carrying plow shares for working the soil, and cultivation of tall crops.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

NEW BOOKS, ETC.

ENGINEERING FOR LAND DRAINAGE. A Manual for the Reclamation of Lands Injured by Water. By Charles Gleason Elliott, C.E. New York: John Wiley & Sons, 1912. 12mo.; 339 pp.; illustrated. Price, $2.

The United States have before them greater drainage problems and possibilities than any other country of the world. Since the drainage of the tract now known as Central Park, in 1858, progress in land reclamation has been steady. The work issues increasing calls for the drainage engineer, and students will find in this concise text much needed information. Fieldwork equipment, engineering technique, the preliminary survey, underdrains, flow in open channels, the location and construction of open ditches, levee systems, the reclamation of tidal lands, the drainage of irrigated, peat, and muck lands—all these phases of the subject are set forth, with useful tables, and instruction as to making close estimates and keeping adequate accounts and records.

DREDGES AND DREDGING. By Charles Prelini. New York: D. Van Nostrand Company, 1911. 8vo.; 279 pp.; 82 illustrations. Price, $3 net.

The first power dredge of which we have any knowledge was designed by one Cornelius Meyer in 1685. It utilized horses in the construction of canals and dykes in Holland. It is a far cry from that clumsy and inefficient piece of apparatus to the marvelous machinery of the modern dredge, which has made possible so much of our present commercial development. The debt of navigation to the mechanical digging machine exceeds only that of drainage and irrigation, water supply and mining. All are under heavy obligation to the dredge for the breadth of their accomplishment. The volume in hand treats of this important subject from all points of view—the nature of soils encountered, the method of taking soundings and hydraulic surveys, the excavation of subaqueous rock, the types of dredges employed in various works and their classification and capacity, hydraulic and pneumatic dredges, dipper and grab dredges, and cost data. The engravings show plainly the distinctive features of the various types and the relation of these features to the work performed. Mr. Prelini has given us a book that is instructive and fascinating in a very high degree.

COMMENTARY ON THE SCIENCE OF ORGANIZATION AND BUSINESS DEVELOPMENT. By Robert J. Frank, LL.B. Chicago: Chicago Commercial Publishing Company, 1911. 8vo.; 280 pp. Price, $2.75.

The author states, and the facts sustain his contention, that a business soundly founded is at least one third a success; the other two thirds being acquired by opportunity and adequate facilities. It is more essential than the average incorporating group realizes that it should clearly understand the advantages and limitations of a corporate body, and the specific advantages which they desire to enjoy; otherwise it remains for future disagreeable developments to enlighten them as to the errors of their initial step. It is not sufficient, as the author emphasizes, that they rely wholly upon the judgment of counsel. The treatise covers in a common sense manner all the usual considerations confronting the organizers of a business corporation. Financing, management, reorganization and consolidation, are plainly set forth, and the promotion of enterprises fittingly receives a separate chapter. An appendix contains contract forms, certificates, by-laws and resolutions, a synopsis of the corporation laws of those States most lenient toward this form of organization, and rules for listing stocks and bonds, with a table showing their earnings. Incorporators, officers and directors, financiers and accountants will all find this work a reliable desk guide.

WARSHIPS AND THEIR STORY. By R. A. Fletcher. London, New York, Toronto, and Melbourne: Cassell & Co., Ltd., 1911.

In writing this work the author disclaims any intention of treating of the structural problems relating to warships, or intricate matters of strategy and tactics; his aim having been to describe in popular non-technical language the more important types of warships favored at different times in different parts of the world. He shows how type has succeeded type, and he describes the main lines of divergence and development. The author reverses the usual practice of treating the warships as incidental to the naval battles, preferring to treat the naval battles as incidental to the warships. The work opens with an introduction, which forms one of the most readable and instructive chapters of the book, and is in fact a digest of the volume which follows. The historical chapter tracing the development of the warship, from the ancient Egyptians to the day of the introduction of artillery, is particularly readable, as are the chapter on iron ships of war and that dealing with guns, projectiles, and armor. The work is written for the layman. It gives him the kind of information he wants, and gives it in an interesting way. The author has done his task well. The half-tone work of the book is particularly good, and the subjects of illustration are well chosen.

A SHORT COURSE IN GRAPHIC STATICS. For Students of Mechanical Engineering. By William Ledyard Cathcart and J. Irvin Chaffee, A.M. New York: D. Van Nostrand Company, 1911. 12mo.; 183 pp.; 58 illustrations. Price, $1.50 net.

The Efficiency of the Large Manufacturing Plant

By Sidney Graves Koon, M.M.E.

READING between the lines of the census bulletin detailing manufactures in New York State, one of the first State reports issued, and covering 16.3 per cent of the total manufactures of the United States, a number of interesting facts are disclosed. It is found, as was to have been expected, that the proportionate output of large establishments is increasing, while that of small plants is decreasing. It also appears that the efficiency of production in the large plant is much higher than in the small one, more product per man is turned out, and (what is of greater real importance) a larger value per man is added to the product as a result of the manufacturing processes. And this "efficiency" has itself shown a marked increase during the five years between 1904 and 1909, covered by the census investigations.

The first item mentioned is due to the concentration of effort and capital, in small plants and small industries as well as large ones, to combinations of men and enterprises, to the rapidly developing idea in manufacturing which has been so aptly expressed in the State motto of Kentucky: "United we stand; divided we fall!" Co-operation is the keynote, and it is finding expression in establishments of all sizes. So it follows that the ratio of the output of the large plants to the total output is increasing.

Plants with an individual annual product of $1,000,000 or more numbered 294 in 1904 and 470 in 1909. They employed 20.9 per cent of the total number of wage earners in 1904 and 25.4 per cent in 1909. They furnished 32.8 percent of the products in 1904 and 37 per cent in 1909. They added value through manufacturing processes amounting to 25.9 per cent of the total in 1904 and 31 per cent in 1909.

A comparison of these figures will show that these large plants produced about 50 per cent more output per man than the average of all plants, and 80 per cent more than did the 40,000 smaller plants. In value added through manufacture, the large plants showed 23 per cent more per man than the total average, and 32 per cent more than the smaller plants. This establishes our second point, the increased economy of operation of the large plant. And it is due in large measure to better facilities for handling materials, cranes and other labor-saving machinery, improved railroad connections and service, and less of the "jack-of-all-trades" in the make-up of the "hands." To what extent the new fad "scientific management" has influenced this result is problematical.

The general gain in efficiency all along the line is shown by the figures for all the five groupings given in the census bulletin, plants with less than $5,000 output; between $5,000 and $20,000; between $20,000 and $100,000; between $100,000 and $1,000,000; and over $1,000,000 annually. The gain in the establishments as a whole was from $2,904 product per "hand" in 1904 to $3,356 in 1909, an increase of 15.6 per cent. In value added during the processes, the gain per hand was from $1,330 to $1,507, or 13.3 per cent.

All of these points are best shown in the subjoined table. In the table, all figures for total values of products and total values added, represent millions of dollars. The total products amounted to $3,369,490,192 in 1909 against $2,488,345,579 in 1904, a gain of 35.4 per cent. The total value added in manufacturing increased from $1,139,742,293 in 1904 to $1,512,585,850 in 1909, or 32.7 per cent. The value added represented 45.8 per cent of the product in 1904; 44.9 per cent in 1909.

Annual Product per Plant.	Date.	Wage Earners.	Millions of Dollars.		Dollars per "Hand."	
			Product.	Value Added.	Product.	Value Added.
Over $1,000,000	1909	255,383	1,246	469	4,879	1,835
	1904	179,488	816	295	4,547	1,646
$100,000 to $1,000,000	1909	438,229	1,413	664	3,224	1,516
	1904	393,872	1,103	531	2,799	1,349
Under $100,000	1909	310,369	711	380	2,290	1,223
	1904	288,587	570	313	2,009	1,104
Totals—All Plants.						
	1909	1,003,981	3,369	1,513	3,356	1 507
	1904	856,947	2,488	1,140	2,904	1,330

Conquering Infection

THE epic work of Gorgas and his associates, by which one of the greatest plague spots on the face of the earth has been turned into a veritable health resort, is now known and appreciated throughout civilization. It is gratifying to realize that like work has been doing in many other tropical regions.

For example, the Gold Coast and other West African colonies have long been branded as graveyards of white colonists. From 1881 to 1897 the white Gold Coast mortality averaged 75.8 in the thousand for each year; in Lagos it was 53.6. Since 1897, however, mosquitoes and rats have been fought on lines laid down by the scientific bacteriologist; water supplies have been purified and protected; and antityphoid inoculations have been made. The result? In the years 1903-1906 the death rate was 24.3; during 1907-1911 it was 17.6; in 1911 it was 13.7. Here is a record fairly emulative of Panama.

India, the home and the source since the dawn of history of many a "world pestilence," has now a standing British army of about 72,000 men, among whom malarial fevers are the most common illness; formerly typhoid was by far the most deadly. Comparatively little progress has been made against the malarias but the enteric diseases have been so well combatted by means of sanitation and inoculations that one might almost be sanguine of their extinction. Five years ago the death rate was 2.66 in the thousand, a marked reduction from former years; in 1910 it was reduced to 1.58; in 1911 it was but 0.63. Nor was all such improvement monopolized by the white residents and soldiers. Among the native Indian troops, which are nearly twice as numerous as the British similar progress has been made. While in the whole native population of "fatalistic" India (which has from time immemorial, up to a few years past, looked upon cholera and the plague as "visitations" it were impious to defy) the death rate in 1910 was 33.20 in the thousand, as against 35.40 in the preceding five years; the birth rate rising *pari passu* from 37.51 to 39.52.

Such achievements as these are in truth but part of a world-wide and constantly more and more victorious fight with disease, and especially with epidemics against which mankind has ever, up to our generation, been almost defenseless. Thus, by reason of the necessities of tropical colonization, are infectious diseases being eliminated from those regions; though of course medical science cannot remedy the high temperatures, which induce in the Caucasian the "tropical wrath," characterized as it so sadly is by intemperance, lassitude, periods of spasmodic mania and of hideously cruel acts toward inoffending and defenceless natives.

When such triumph over disease can be achieved despite the formidably adverse conditions obtaining in the tropies there should be an even greater measure of success in the temperate zone; while failure to eliminate disease-transmitting insects, and to preserve foods and waters pure, must in reciprocal degree be discreditable in those regions of the earth where sanitation is easier to effect and civilization more advanced.

Bacterial Purification of Water and Sewage

(Concluded from page 37.)

Nevertheless, the rural community and the large private estates in the country have similar problems which have to be faced and solved. In the latter case, especially where convenience has demanded an up-to-date water system, there is the greatest need of a careful scientific study to the end that the final disposal of the wastes shall be safe and complete. As a rule too little attention has been given to this phase of the subject by those most interested. It is generally thought sufficient to get the sewage out of sight under the ground somewhere and as long as no obvious nuisance arises, no further thought is given to it. The fact must be borne in mind that the purifying agency of the soil lies quite close to the surface. At moderate depths, these being greater with the more open soils, the air supply is insufficient for the proper action of the bacterial life and the continuous discharge of sewage under ground in such a way that it tends to sink into still lower depth is a mere evasion of the real problem. This sewage mingles with the ground water and will reappear at some point, possibly remote, possibly in the well or spring of the same place, or of a neighbor, but in all cases practically unchanged in character. Examples are not lacking in which disease-producing bacteria have been conveyed many hundreds of feet through compact soil. Several typhoid fever epidemics resulting from such a situation have been recorded. The water and sewage problems of country homes depend upon so many local factors that any general discussion of them would be quite futile. This is a matter, however, which justifies most careful study in each particular case, and the science of sewage disposal has now advanced to such a point that satisfactory and economical solutions are always possible.

Insects and Disease

(Concluded from page 34.)

the non-immune population. Since this mosquito breeds by preference in fresh, clean, quiet water, the first thing to do in attacking this species is to render collections of water inaccessible to the mosquito. These are usually found to be water-containers of various sizes, such as barrels, tanks, cisterns, tin cans, sags in roof-gutters and the junction of the leaves with the stem on plants of the *Agava* family. Breeding places may be screened, drained, salted, oiled, stocked with fish or destroyed.

It is also necessary that measures be taken to prevent the mosquito from becoming infected and to this end all cases of fever occurring in the yellow fever belt should be screened for the first three days of illness, and upon the recovery or death of the patient the house should be fumigated to kill mosquitoes. For this purpose, sulphur dioxide, which may be produced by burning sulphur in the proportion of two pounds to the thousand cubic feet of initial air space, is perhaps the best agent. Mosquitoes may also be killed by burning pyrethrum or tobacco, but these latter methods are less efficacious. It should be borne in mind that formaldehyde which is used as a fumigating agent for certain diseases will not kill insects. It is interesting in this connection to note that in those locations in the tropics where yellow fever is endemic the disease is probably kept alive by infants in arms who have it in mild form and thus continue the cycle between the mosquito and the human species.

The yellow fever mosquito is essentially a domestic animal and as far as its relation to the disease is concerned need be considered only in connection with its proximity to the home of man. The malaria mosquito on the contrary does not necessarily live in close proximity to man and will breed in almost any deposit of fresh water which is quiet and not stocked with fish or insects which destroy the mosquito larvæ. The same general methods of extermination as outlined above may be used, but they should be carried on in a

wider radius and should include the drainage of swamps. In addition, the human cycle of the disease may be partially controlled by the daily administration of small doses of quinine to all persons living in the infected zone. Also, it should be the rule to sleep under a well constructed bed-net and endeavor as far as possible to avoid being bitten by mosquitoes at all times. To-day malaria is the great scourge of the tropics. It has laid waste and prevented the occupation by the human species of a greater portion of the globe than any other disease. The Island of Mauritius for example, whose name was formerly synonymous with good health has in recent years had an enormous amount of malaria due to the introduction of the *Anopheles* by ships and the importation of the germ in the persons of immigrants, with the result that what was formerly a great sanatorium is now an endemic malaria focus. Since this disease may be controlled and limited by the extermination of *Anopheles* mosquitoes, it is the duty of communities in which this species abounds to rid themselves of this menace to health and commerce.

Reference has already been made to the rôle of the flea in the transmission of plague. This is of extreme importance because plague is primarily a disease of rodents and secondarily and accidentally a disease of man. Almost every fur-bearing animal has fleas which may be easily infected by the ingestion of infected blood. Thus, it is found that the rat flea, the ground squirrel flea, and the tarbagan flea have all been convicted at one time or another of having transmitted bubonic plague. The remedy is obvious. If the animal carrying the flea which bridges the space between the infected rodent and the well human being be excluded from the home of man there need be little fear of bubonic plague. Therefore, the work which was carried on in California for the eradication of plague was directed very largely at the extermination of rodents. This may be accomplished by a simultaneous attack upon the home and the food supply of the rat and by killing them by the use of poisons and traps. Plague is out upon its march around the world, and for the past five years has been making a steady advance up the Spanish main. Very recently it has appeared in Porto Rico and for all we know it may now be smouldering in the rodent population of some of our large Atlantic seaports. If a survey of these rodents is made now and the foci of infection stamped out much money and many lives may be saved in the future. This is a measure of immediate necessity if we would protect our sanitary and commercial interests.

Not the least interesting aspect of the transmission of disease by insects is the rôle played by the tick in this regard. One species of this insect is known to carry African tick fever and we have a strictly American disease almost wholly confined to the Western States, Rocky Mountain tick fever, which is carried by another species, the *Dermacentor andersoni*. The organism of this disease has not yet been discovered but the season of its prevalence is coincident with the period of greatest tick prevalence and it is found only in those localities in which ticks occur. Two types of Rocky Mountain spotted fever are known. The mild, which occurs in Utah, Wyoming, Idaho, Nevada and eastern California, Oregon and Washington, and the severe form, which is found in Montana. Usually the disease is confined to one side of a valley and in almost every instance there is a history of the patient having been bitten by a tick. Further, the disease has been experimentally transmitted from one human being to another, from human beings to guinea pigs, and from guinea pigs to guinea pigs by the bite of the tick. Active work is now being carried on in Montana by the United States Public Health and Marine Hospital Service for the eradication of the disease. The general plan of operation includes the extermination of the small mammals on which the tick lives during the earlier portion of its developmental cycle and the "dipping" of the domestic stock on which the ticks spend a portion of their adult life in antiseptic solutions. Also, the land on which these ticks are found is being cleared and

burnt off. This work has been in operation for only a single summer, but it has resulted in the total cessation of cases in what was hitherto a badly infected locality.

Typhus fever, which also goes by the names of "jail fever" and "ship fever," and which in former years was regarded as the inevitable companion of war and famine, until very recently, was thought to have entirely disappeared from our country. It has, however, continued in Mexico where the researches of Nicole, Ricketts and Wilder, and Anderson and Goldberger have demonstrated that it is carried by the body louse, the *Pediculus vestimenti*. Recently Anderson and Goldberger have demonstrated that the head louse, *Pediculus capitis*, may also transmit the disease. More important than all, Anderson and Goldberger, working in the Hygienic Laboratory of the United States Public Health and Marine Hospital Service at Washington, D. C., have proven the identity of Brill's disease, a wide-spread disease in the United States, with typhus fever. It is thus seen that typhus fever of a mild type is prevalent in the United States. Since the disease is carried by lice, and since lice are the almost inevitable companions of filth and squalor, it is seen that the best way to prevent this disease is to kill lice, and by cleanliness to render their environment unsuitable for their existence. Brill's disease, or mild typhus fever, occurs often in children. Lice are found often on children. Lousy children should therefore be excluded from school until they have been freed from this disgusting parasite.

It is not at all improbable that bedbugs also carry disease. While this has not been proven definitely there are numerous instances on record in which the evidence tends to incriminate this species. The remedy is apparent.

The Destruction of the "Schwaben"

THE old wooden airship shed at Duesseldorf is fast gaining a reputation as the aerial "hoodoo dock." When everything about the Zeppelin ships appeared secure at last, after four of them had been making record trips, the "Schwaben" (fortunately insured at her full value against fire) was destroyed as if by a bolt from a clear sky, after her 214th passenger trip, in close proximity to the same Duesseldorf shed that twice wrecked the "Deutschland." She was at anchor, weathering a storm for hours, and trying to avoid a risky entrance into the shed, when a severe gust raised her into the air, broke her back and ignited the escaping gas, presumably by frictional electricity.

The disaster must be ascribed to the over-confidence inspired by handling the ship safely in so many stormy landings, and to the treacherous nature of the wind, which, as aviators well know, may all of a sudden show quite unfamiliar antics and effects. Again the lesson was emphasized that men, even in great numbers, cannot replace reliable anchors. The four concrete blocks sunk into the ground, around which the ship swings like a weather vane, held by a swivel at the ends of four converging cables, were not in use, because these are placed farther from the shed to give room for the ship's movements.

The least expensive way to make old sheds like that at Duesseldorf safe, would be to erect one of those anchoring towers of steel lattice work which have been often suggested, and around which the ship at anchor could swing in safety, clear of the ground, until the wind's subsiding permitted the safe entrance into the shed. The English army has tried this plan with excellent success on a small scale. An interesting feature of the "Schwaben's" disaster is its resemblance to certain aeroplane accidents. The breaking of the airship's back was due to the same causes that have stripped monoplanes in the air of their wings—the great resistance of the inertia of concentrated weight against yielding under a very sudden and heavy wind pressure. It could have been avoided by lightening the cars of all removable weight and ballasting inside the cabin and the passageway.

This would have equalized the strain. If the weight of the passengers had still been in the cabin, possibly nothing would have happened, for the airship did not really break away, as otherwise the men holding it would not have been burned. Such "explosive" lifting effects of wind gusts can also occur only near the ground and near obstacles like the shed, where the gust may "jam" under the ship. It should be noted that the "Schwaben" was not pushed back, but lifted straight up like an aeroplane. It would do no harm to relieve the cars in future of all tanks, stores and other weights that can be possibly arranged along the passageway, as already done in the Siemens-Shuckert dirigible, although there is ample strength for free flight.

If there had been no smashing there would have been no escaping gas and no electric sparks to ignite it. But a water sprinkling device (tried on the "Suchard") inside the hull and above the ballonets could easily guard against frictional electricity in critical situations, and German manufacturers are now hard at work upon a balloon cloth that cannot be electrified by friction or concussion even in dry air.

The Current Supplement

IN this week's SUPPLEMENT, No. 1906, Arthur J. Hoskin discusses very lucidly the legal and technical points which require consideration in connection with the opening of new mines.—C. M. Chapman writes on Methods for Testing Coatings for Cement Surfaces.—A richly illustrated article by L. Claremont tells our readers of the wonderful gem industry carried on by the natives in Ceylon.—The benefits to mankind which have been gained by experiments upon animals cannot be brought with too great emphasis before the public. Much has been written on the subject, but the article which appears in our current issue is one of unusual merit and persuasive force and should be read by all, especially by those who perhaps may not be very fully informed on the subject and may possibly still entertain some doubt regarding the great gains which medical science has to record in this quarter.—Day Allen Willey contributes an illustrated article on the remarkable engineering feat accomplished in the building of a railway in ice-bound Alaska.—A report of some tests of a simple engine taking steam at less than atmospheric pressure is of particular interest in connection with the utilization of solar energy.—Dr. Zahm, the noted American authority, contributes a masterly article on Elements of Theoretical Aeromechanics, which will run as a serial through two or three issues.

Centennial of Gas

WHEN and where gas was first used, it seems to be difficult to ascertain. Yet 1912 is regarded as the one hundredth anniversary of the introduction of illuminating gas. Apparently the event to be celebrated is the organization in 1812 of the London Gas Light and Coke Company. Gas, however, was used for illuminating purposes long before. Murdoch used it for lighting as early as 1795 and perhaps earlier. At all events, in 1798, he put up a gas plant for Boulton, Watt and Company, in Soho. The American city of Baltimore is credited with being the first to apply illuminating gas practically to general illumination. There was a small plant in Newport, Rhode Island, as early as 1813, which antedates the Baltimore plant by eight years.

Tunnels in Constantinople

IT is reported that the Turkish council of state is studying a plan for an underground railway to connect Stamboul with Pera, under the Golden Horn. A more ambitious plan, which English engineers are said to have in hand, contemplates a double tube under the Bosporus, between the extreme points of Stambul and Haidar Pasha, to connect the railway systems of European and Asiatic Turkey.